

Service Manual

Heraeus Megafuge 8

Sorvall ST8

Thermo Scientific SL8

PN: 12007200-01



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INTRODUCTION



CAREFULLY READ THIS MANUAL BEFORE SERVICING YOUR INSTRUMENT.

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PURPOSE

This manual contains maintenance instructions intended for use by a qualified maintenance or service technician.

It is organized to provide information on the theory of operation to assist in troubleshooting for personnel of Thermo Fisher Scientific and authorized service organizations. Moreover, it outlines parts replacement and calibration procedures for putting the centrifuges back into service.

Should a specific maintenance problem arise which is not covered in this manual, please contact our after sales or product support department.

Heraeus Megafuge 8
Sorvall ST8
Thermo Scientific SL8



Environmental conditions	- Indoor use only	
	- Max. height above sea level 2000m	
	- Max. relative humidity 80% at 31°C	
	- Linear decrease until 50% relative humidity at 40°C	
Permissible ambient temperature	+2°C to +35°C	
Timer range	10sec – 99h 59min and hold mode	deviation: +/- 10 sec.
Max. speed	16000 rpm	accuracy: +/- 10rpm
Min. speed	300 rpm	accuracy: +/- 10rpm
Max. kin. energy	< 8.2 kNm	
Max. sound level at top speed	< 61 dB (A)	

Volt Version	120V	230V
Heat output BTU/h	1060	
Power consumption	310 W	
Rated current	5.0 A	2.0 A
Height (lid closed)	31 cm / 12.2 in	
Height (lid open)	67 cm / 26.8 in	
Width	37 cm / 14.6 in	
Depth	48 cm / 18.9 in	
Weight (without rotor)	35 kg / 77 lbs	

Rotor / bucket	Rotor name	Allowable imbalance [g]	max. speed	max. x g	max radius
75005701	TX-150 Rotor	10	4500	3260	14.4
75005702	TX-150 Round Bucket	10	4500	3260	14.4
75005703	TX-150 Oval bucket	10	4500	3260	14.4
75005704	TX-100S	10	4500	3215	14.2
75005705	TX-100	10	4500	3260	14.4
75005706	M-10 Rotor	10	4400	2576	11.9
75005723	M-10 Unsealed Bucket	10	4400	2576	11.9
75005721	M-10 Sealed Bucket	10	4400	2381	11.0
75005600	MT-12 Rotor	4	13000	16438	8.7
75005709	HIGHConic III Rotor	10	8700	10155	12.0
75003623	CLINIConic Rotor	10	4400	3030	14.0
75005719	MicroClick 30x2 Rotor	4	14000	21694	9.9
75005715	MicroClick 24x2 Rotor	4	16000	24327	8.5
75003473	Hematocrit Rotor	1 capillary	13300	16810	8.5
75005643	PCR Strip Rotor 8x8	4	15000	17860	7.1

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Servicing schedule

This chapter describes the maintenance work to be performed on a yearly basis. A checklist can be found in the attachment A-1.

Maintenance routine without dismantling the centrifuge

Electrical installation and safety

- Switch OFF the centrifuge and disconnect the unit from power, check voltage supply and mains fusing (16 (15) Amps, slow blow characteristic).
- Check condition of plug and wall socket - (let) replace defective parts.
- Check cord condition and fixing / connection - replace or refit it.
- Check condition of instrument socket and replace it in case of bad contacts.

Location and mechanical installation

- Check the base (ground, table, trolley with lockable wheels etc.) for resonance-free and stable conditions.
- Check for a well ventilated place and sufficient distances to walls or adjacent equipment, without exposition to direct sunlight.
- Check the leveling of the centrifuge drive with help of a spirit level.

Lid latch mechanism and safety circuit

- Connect the centrifuge to power and switch ON.
- Check for correct lid closing and opening - if in disorder, readjust lid, hinges and/or lid latch.
- Check the rubber gasket for correct sealing and replace, if damaged.
- Check gas lid stay for correct function.
- Check the electronic safety circuit: start the centrifuge. Let it shortly run and press stop. The lid must not be unlocked by the microprocessor as long as the speed is more than 60 rpm - if safety circuit is out of function, replace main board.

Cleanliness of rotor chamber and motor cover

- Open the lid and remove the rotor by pressing the green AutoLock button in the center of the rotor.
- Clean the spin chamber with a dry and absorbent cloth (remove all dust and moisture - see also page 2-18 for cleaning).
- Check the cleanliness of the motor cover and take special care of the slot between the bowl and the motor cover: penetrating fluids can damage the motor and/or electronics and foreign objects may block the air flow.

Condition and sealing of rotors and accessories

- Check the condition of rotors and accessory parts (especially all supporting or stressed partitions): the rotor and/or accessory parts must not be used any longer, if there are visible traces of mechanical damage or corrosion.
- Check the condition of rotor and/or accessory sealing and replace them in case of malfunction.

AutoLock and motor shaft

- Check the perfect condition of the AutoLock system. In case of malfunction use tool Kit # 70904693 to change the AutoLock. (see page 5-7)
- Check the condition of the drive motor shaft: the centrifuge must not be used any longer, if the drive shaft is damaged (e.g. bend or it's bearings are worn out).

Temperature level

- Check the air inlet slots for free ventilation. Insufficient air flow will lead to an inadmissible temperature rise of the motor and electronic parts.

Imbalance behavior

- install available and empty rotors and check the imbalance behavior with rotor dependant cut off and run through weights (see page 2-18) and replace worn anti vibration mounts, faulty main board or sensor cover.

Maintenance routine after dismantling the centrifuge casing

Motor supporting elements

- Check the anti vibration mounts of the drive motor and replace them in case of increased rubber abrasion or abnormal occurrence of imbalance but at least after 3 years of usage.

Braking circuit

- Check the function of the braking circuit (warming up of brake resistor, even and noiseless brake effect) and replace defective parts in case of malfunction.

Clamp and plug connections of wires

- Check the clamp and plug connections of all leads on the main board and all electrical Protection earth core and grounding connections.
- Check the grounding connection for continuity and all grounding plug connectors. (see also page 2-19 Electrical Safety Check)
- Check insulation resistance and accessible current. (see page 2-19)

Trouble shooting

Malfunctions without error code

Error	Error Cause	Possible Error Source	Corrective Procedure
Display remains off	no mains voltage supply	power switch with integrated thermal over current cut out	Check supply voltage at X16. If no voltage is present, check power switch, instrument socket and voltage supply. Replace defective parts
		mains fuse or circuit breaker failed	
		faulty mains cord or instrument socket	
	no low voltage supply for display	faulty connection from main board to display	Check presence of 5V (LED V75), 15V (LED V78) and 24V (LED V79) control voltages on main board. If a voltage is missing (LED off) replace main board. Check the display cable (SSTP patch cable). Replace the display.
faulty display or main board			
Display backlight is lit, but nothing displayed or display shows cryptically (wrong) characters	data connection disturbed	faulty connection from main board to display	Check for interferences such as radios, micro wave ovens, etc. Check for good grounding connection. Check the display cable (SSTP – shielded cable). If no other error source can be identified, replace main board.
No display backlight	LCD powersafe mode		Press any button. To switch off the LCD powersafe mode enter the system menu.
	faulty backlight	faulty backlight	Replace display.
Display shows BOOTING...	CPU program reset may be caused by EMI	supply voltage drop (>10%)	(Let) improve the power supply. If the voltage drops often, use a voltage stabilizer.
		bad or missing grounding connection	check all grounding connections

Error	Error Cause	Possible Error Source	Corrective Procedure
Drive makes noises, no good separation result	mechanical	worn anti vibration mounts	Check anti vibration mounts and replace if worn or older than 3 years. (see page 5-6)
		Trunnions of swinging bucket rotor not greased sufficiently	Inform users that trunnions must be cleaned and greased on a regular basis. See user manual for more information.
		Buckets of swinging bucket rotor not weight identical	Check weight index on buckets.
		bad motor bearings	Turn motor by hand. If a scratching noise is audible, replace complete motor.
	electrical	missing phase	Check winding and insulation resistance of the motor (see test points). If the motor and it's leads are ok, replace main board.
		faulty electronic	
Buttons inoperative	overlay or overlay adaptor has no contact	ribbon cable broken, or no contact	Check correct sitting of ribbon cable in overlay adaptor. Check ribbon cable between overlay adaptor and main board. Replace defective overlay, overlay adaptor or ribbon cable.

Error-Codes

Should multiple errors occur at the same time, the centrifuge will display up to 3 errors at once, by alternating them on the display.

Overview (details on following pages)

Error	Description
E-001	System clock unstable
E-002	Main state machine corrupted (software)
E-005	System reset by watchdog
E-008	Check sum error ROM test
E-010	NV-RAM communication error
E-011	NV-RAM does not match E-PROM
E-012	Check sum error NV-RAM constant area
E-014	Chamber over temperature: $t > 50^{\circ}\text{C}$
E-015	Temperature sensor open
E-016	Temperature sensor short
E-017	Speed above rotor recognition speed limit
E-019	Rotor code not in rotor table
E-020	Rotor code corrupted
E-021	Rotor recognition and speed 1 measurement disturbed
E-022	Speed 2 measurement disturbed
E-023	Difference between speed 1 and speed 2 signals
E-025	Lid could not be opened
E-027	State of lid latch micro switches implausible
E-029	Motor does not turn
E-030	Control voltage failure
E-031	Motor over temperature: $t > 150^{\circ}\text{C}$
E-033	High pressure in cooling system
E-034	Over voltage in power circuit
E-036	Over voltage or short circuit at inverter
E-038	Lid latch current abnormal (Speed 0)
E-040	Acceleration too slow
E-041	Offset voltage of imbalance sensor implausible
E-045	Safety test during restart failed
E-046	Lid opened during run
E-048	Software state machine error
E-050	Software state machine error
E-051	Software state machine error
E-052	Software state machine error
E-053	Software primary mask reading error
E-054	Software primary mask writing error
E-060	Chamber under temperature: $t < -20^{\circ}\text{C}$
E-072	Software state machine error

Error	Description
E-074	Latch motor control fault
E-077	System health check error
E-078	Set speed above max speed
E-079	Speed above rotor maximum: >25rpm
E-080	Rotor detection failed
E-081	Second top speed check failed
E-083	Brake resistor over temperature
E-098	Imbalance detected
E-101	Temperature measurement shows great deviations to expected values
E-104	Temperature measurement could not be completed
E-105	Software state machine error
E-106	Lid latch current abnormal (Speed >0)
E-107	Main board over-temperature

Detailed error description and action plan

Error	Possible Error Source	Corrective Procedure	Possible spare part
E-001	System clock on main board failed	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-002	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-005	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-008	ROM failed	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-010	Wrong NV-RAM, communication between NV-RAM and main controller disturbed	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, check NV-RAM and socket. Insert the correct NV-RAM	NV-RAM
E-011	check versions of NV RAM and E-PROM	replace NV RAM with correct one	NV-RAM
E-012	NV-RAM failed	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace NV-RAM.	NV-RAM
E-014	Compressor does not work, low refrigerant, fan inoperative	Refrigerated units only: The rotor is decelerated with maximum braking. DO NOT TOUCH ANY INSIDE PARTS AFTER OPENING THE LID! BURN HAZARD! Perform compressor test (Service Menu), check fan and remove dust from condensing unit. Replace defective parts. In case of low refrigerant, use leak detector, repair leak and recharge system.	Compressor Fan TEV Refrigerant
E-015	Temp. sensor, control circuits	Refrigerated units only: The rotor is decelerated with maximum braking. Disconnect PT1000 from main board (X3) and check resistance (R = 1,000Ω @ 0°C or 1,078Ω @ 20°C). Replace faulty PT1000 or faulty main board.	PT1000
E-016	Temp. sensor, control circuits	Refrigerated units only: The rotor is decelerated with maximum braking. Disconnect PT1000 from main board (X3) and check resistance (R = 1,000Ω @ 0°C or 1,078Ω @ 20°C). Replace faulty PT1000 or faulty main board.	PT1000
E-017	Power interruption, Reset during run	After power reset the speed is above 2,000rpm. The rotor is coasting freely. Check mains power supply. Restart centrifuge. If the error persists replace main board.	Main board

Error	Possible Error Source	Corrective Procedure	Possible spare part
E-019	Wrong rotor installed, old version of NV-RAM	The rotor is decelerated with maximum braking. Install correct rotor. Install latest NV-RAM version.	Rotor NV-RAM
E-020	Wrong rotor installed, Rotor coding faulty, Interference, NV-RAM faulty	The rotor is decelerated with maximum braking. Check rotor in other centrifuge. If rotor is found faulty, return to factory for repair. DO NOT REMOVE THE CODE RING! Separate motor cables and signal cables, otherwise interference is caused. If the error persists, replace NV-RAM	Rotor NV-RAM
E-021	Sensor cover faulty, Interference	The rotor is coasting freely. Separate motor cables and signal cables, otherwise interference is caused. Replace sensor cover.	Sensor cover
E-022	Sensor cover faulty, Interference	The rotor is coasting freely. Separate motor cables and signal cables, otherwise interference is caused. Replace sensor cover.	Sensor cover
E-023	Sensor cover faulty, Interference	The rotor is coasting freely. Separate motor cables and signal cables, otherwise interference is caused. Replace sensor cover.	Sensor cover
E-025	Latch failed, Cable interrupted, Main board failed	Check operation of stepper motor when pressing lid button. Disconnect stepper motor from main board (X8) and check resistance (1→2 = 46Ω, 3→4 = 46Ω). If stepper motor/cable is ok, replace main board.	Lid latch
E-027	Latch or wires broken	Switch 2 is closed when switch 1 is open = implausible. Check micro switches and wires. Replace latch. If latch is ok, replace main board.	Lid latch
E-029	No rotor installed, Motor/rotor blocked, Motor faulty, No speed signal, Motor driver on main board faulty	The rotor is coasting freely. CHECK FOR NO ROTATION OF ROTOR THROUGH LID WINDOW BEFORE OPENING THE LID! Check the motor/rotor for no blocks. Turn rotor by hand and check for no abnormal noise and friction. Close lid and press start. Check through window if rotor starts turning. If rotor turns, check cables of sensor cover and/or replace it. If rotor does not turn, check winding resistance and insulation resistance of motor. If motor is ok, replace main board	Motor Main board Sensor cover
E-030	Mains voltage too low, Main board failed	The rotor is coasting freely. Check mains power supply. Replace Main board	Main board
E-031	Hot motor, no air circulation, faulty over temp. cut-out.	The rotor is coasting freely. DO NOT TOUCH THE MOTOR, ROTOR AND/OR ADJACENT PARTS! BURN HAZARD! Wait for motor to cool down. Check ventilation slots for cleanliness and check fans for operation. Turn rotor by hand and check for no abnormal noise and friction. Disconnect motor over temperature cut out from main board (X11) and check it for continuity. Replace motor in case of malfunction.	Motor Fan

Error	Possible Error Source	Corrective Procedure	Possible spare part
E-033	No ventilation, Pipes blocked, Faulty over pressure switch	Refrigerated units only: The rotor is decelerated with maximum braking. Check ventilation slots for cleanliness and check fans for operation. Disconnect over pressure switch from main board (X18) and check it for continuity. Replace it in case of malfunction. Check for blocks in the refrigeration pipes (trained and authorized refrigeration engineers only)	Fan TEV OP switch
E-034	Brake resistor open, main board faulty	The rotor is coasting freely. Disconnect brake resistor from main board (X20) and check resistance (120Ω). Replace if faulty, otherwise replace main board.	Brake resistor Main board
E-036	Brake resistor open or short, Motor winding short, Main board faulty	The rotor is coasting freely. Disconnect brake resistor from main board (X20) and check resistance (120Ω). Replace brake resistor if faulty. Disconnect motor from main board (X10) and check winding resistance. Replace motor if faulty. Otherwise replace main board	Brake resistor Main board Motor
E-038	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-040	Extreme imbalance, motor bearings, motor phase missing	The rotor is decelerated with maximum braking. Check for imbalanced load. Check motor for smooth turning. Disconnect motor from main board (X10) and check winding resistance. Replace motor if faulty. Otherwise replace main board.	Motor Main board
E-041	Imbalance sensor faulty	The rotor is decelerated with maximum braking. Replace sensor cover.	Sensor cover
E-045	Power interruption during run AND speed signal error	The rotor is coasting freely. During run a power outage happened. After power recovery the rotor speed is 0. The rotor is turned at low speed and no speed signal is detected. See "E-29"	Sensor cover Main board
E-046	Emergency lid opening detected during run, Faulty micro switch	The rotor is decelerated with maximum braking. CLOSE LID IMMEDIATELY! NEVER OPEN THE LID WHILE THE ROTOR IS SPINNING. Wait for rotor to stop. In case of faulty micro switches replace latch.	Lid latch
E-048 to E-052	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-053 to E-054	Internal software problem	The rotor is decelerated with maximum braking. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-060	Compressor control fault, Temperature probe fault	Refrigerated units only: The rotor is decelerated with maximum braking. DO NOT TOUCH THE INSIDE OF CHAMBER AND ROTOR WITH BARE HANDS! FREEZE HAZARD! Disconnect PT1000 from main board (X3) and check resistance (R = 1,000Ω @ 0°C or 1,078Ω @ 20°C). Replace if faulty. Otherwise replace main board.	Main board PT1000

Error	Possible Error Source	Corrective Procedure	Possible spare part
E-072	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-074	Latch motor broken / blocked, Main board failed	The rotor is decelerated with maximum braking. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. Check the latch by opening and closing the lid. If faulty, replace lid latch. Otherwise replace main board	Lid latch Main board
E-077	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-078	Motor control fault	The rotor is decelerated with maximum braking. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-079	$n > n_{\text{rotor max}} + 25$	The rotor is coasting freely. The controller is not able to control the rotor speed properly. Replace main board.	Main board
E-080	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-081	Internal software problem	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-083	Brake resistor overheated, No air circulation, Main board failed	The rotor is coasting freely. DO NOT TOUCH THE BRAKE RESISTOR! BURN HAZARD! Check ventilation slots for cleanliness and check fans for operation. Disconnect brake resistor from main board (X20) and check resistance (120Ω). Replace brake resistor if faulty. Otherwise replace main board	Main board Brake resistor Fan
E-098	Imbalanced load	The rotor is decelerated with maximum braking. Wait for rotor to stop, open lid and check for imbalance, greased trunnions, etc. Balance the rotor and start again. If the error persists check anti vibration mounts. Replace mounts if worn or older than 3 years. If the error persists replace sensor cover.	AV mounts Sensor cover
E-101 to E-104	Measurement shows great deviations (+/- 5°C) to expected values.	Refrigerated units only: The rotor is decelerated with maximum braking. Disconnect PT1000 from main board (X3) and check resistance (R = 1,000Ω @ 0°C or 1,078Ω @ 20°C). Replace PT1000 if faulty. Otherwise replace main board. Check also for interference.	PT1000 Main board
E-105	Internal software problem	The rotor is decelerated with maximum braking. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board

Error	Possible Error Source	Corrective Procedure	Possible spare part
E-106	Main board failed	The rotor is decelerated with maximum braking. Wait for rotor to stop and turn the power switch off. Wait 5 seconds before turning it back on. If the error persists, replace main board.	Main board
E-107	No air circulation, Fan inoperative	The rotor is coasting freely. Wait for rotor to stop and turn the power switch off. Wait 30 minutes to allow cooling down before turning it back on. Clean ventilation slots. Remove dust from main board (unit disconnected from mains!). Check fan (refrigerated units only). Replace fan if faulty. If the error persists replace main board.	Fan Main board

Test Points

Test Point	Unit Value	Conditions
Mains input X16	230V / 120V	CAUTION! Mains potential! Mains cable connected, power switch ON
Motor X10	A-B 5.6 Ω A-C 5.6 Ω B-C 5.6 Ω	Ambient at 20°C, plugs disconnected from main board.
		Any phase to ground must have an infinite resistance.
Brake resistor X20	120 Ω	Ambient at 20°C, cables disconnected from main board
Over temperature cut-out motor X11	15 VDC 0 VDC	Cables connected, power ON Lid open Lid closed
	open short	Cables disconnected, power OFF Lid open Lid closed
Over temperature cut-out brake resistor X9	15 VDC 0 VDC	Cables connected, power ON Failure Good
	open short	Cables disconnected, power OFF Failure Good
Lid latch micro switches X14	Pin 1+4 0 VDC 2.5 VDC	Cables connected, power ON Lid closed Lid open
	Pin 1+4 short open	Cables disconnected, power OFF Lid closed Lid open
	Pin 2+3 5 VDC 0 VDC	Cables connected, power ON Standby Stepper motor moves into zero state after lid has been opened
	Pin 2+3 open short	Cables disconnected, power OFF Standby Stepper motor moves into zero state after lid has been opened
	Pin 5+6 0 VDC 2.5 VDC	Cables connected, power ON Lid closed Lid open
	Pin 5+6 short open	Cables disconnected, power OFF Lid closed Lid open
Lid latch stepper motor X8	Pin 1-2 46 Ω Pin 3-4 46 Ω	Ambient at 20°C, plug disconnected from main board

Test Point	Unit Value	Conditions
DC bus voltage LED V41 DC BUS (red)	lit	All cables connected, power switch ON, lid closed
	dimly lit	All cables connected, power switch ON, lid open
15 V control circuit power supply LED V79 (red)	lit	All cables connected, power switch ON
Speed signal LED V11 RUN (green)	lit	All cables connected, power switch ON, lid open, rotor installed , rotor / motor is turned by hand. The LED must light 2 times during 1 revolution.
	flashing	All cables connected, power switch ON, lid closed, rotor installed , start pressed, rotor spinning. The LED flashes 2 times per revolution. At speeds above 2000 rpm the LED is lit.
5 V control circuit power supply LED V75 (green)	lit	All cables connected, power switch ON
24V control circuit power supply LED V79 (green)	lit	All cables connected, power switch ON

System menu & Service menu

How to enter the system menu


The system menu allows the user to make advanced settings and read units values as additional information for service calls.


To enter the system menu

1. Switch off the centrifuge
2. Press and hold any button on the overlay
3. Switch on the centrifuge
4. When

Enter SYSTEM Menu?
SYSTEM MENU

appears, release the button

5. Press  to enter the service menu

6. Use  to scroll through the menu.

7. To exit the system menu and save changes press



To exit the menu without saving the changes press



See page 2-16 for complete menu structure.

How to enter the service menu

The service menu provides guidance for troubleshooting, such as error history list, statistics and tests.

To enter the service menu


1. Switch off the centrifuge
2. Press and hold buttons “Program 1” and “Program 2”




3. Switch on the centrifuge

4. When
- Enter Service Menu?
SERVICE MENU

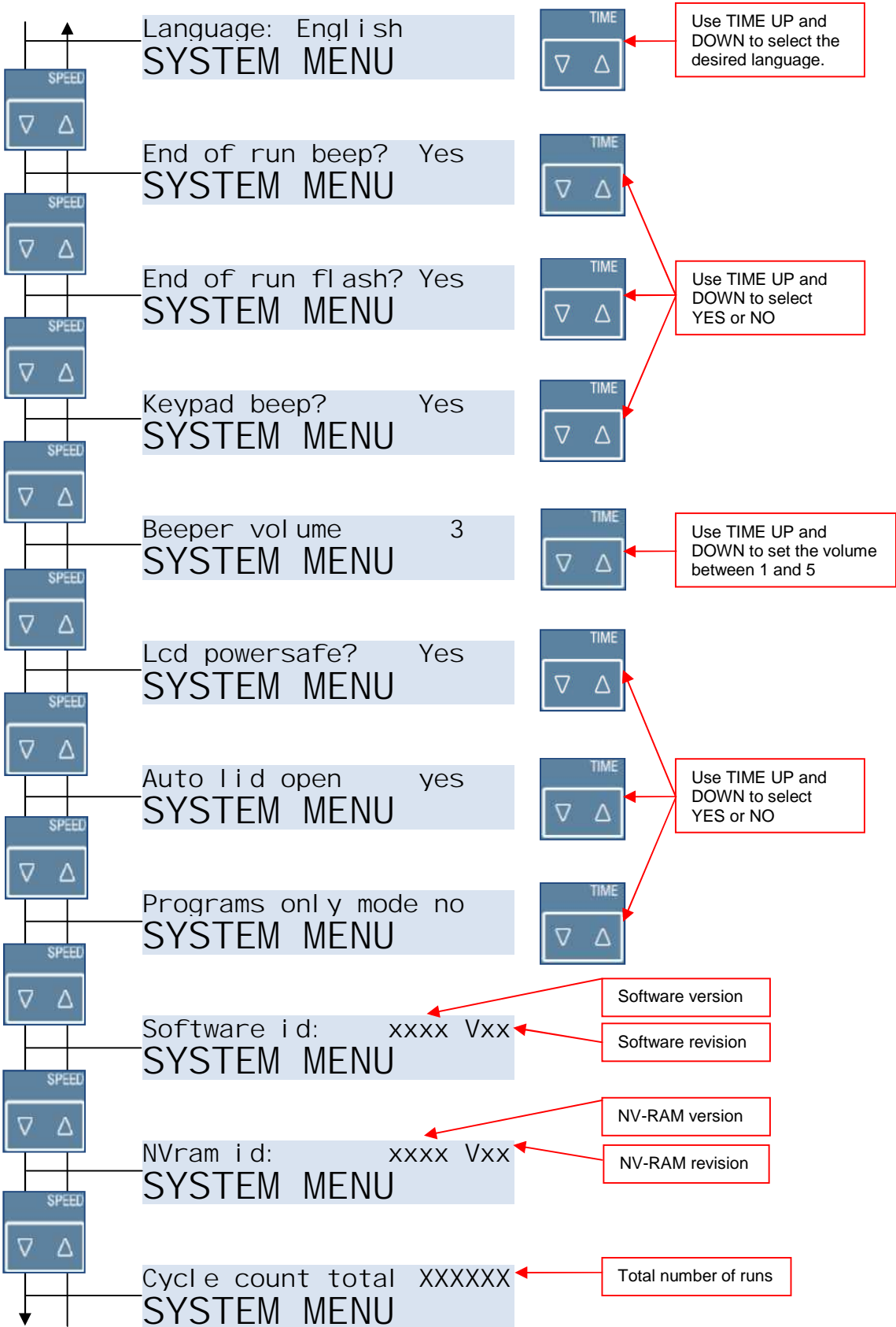
appears, release “Program 1” and “Program 2”

5. Press  to enter the service menu

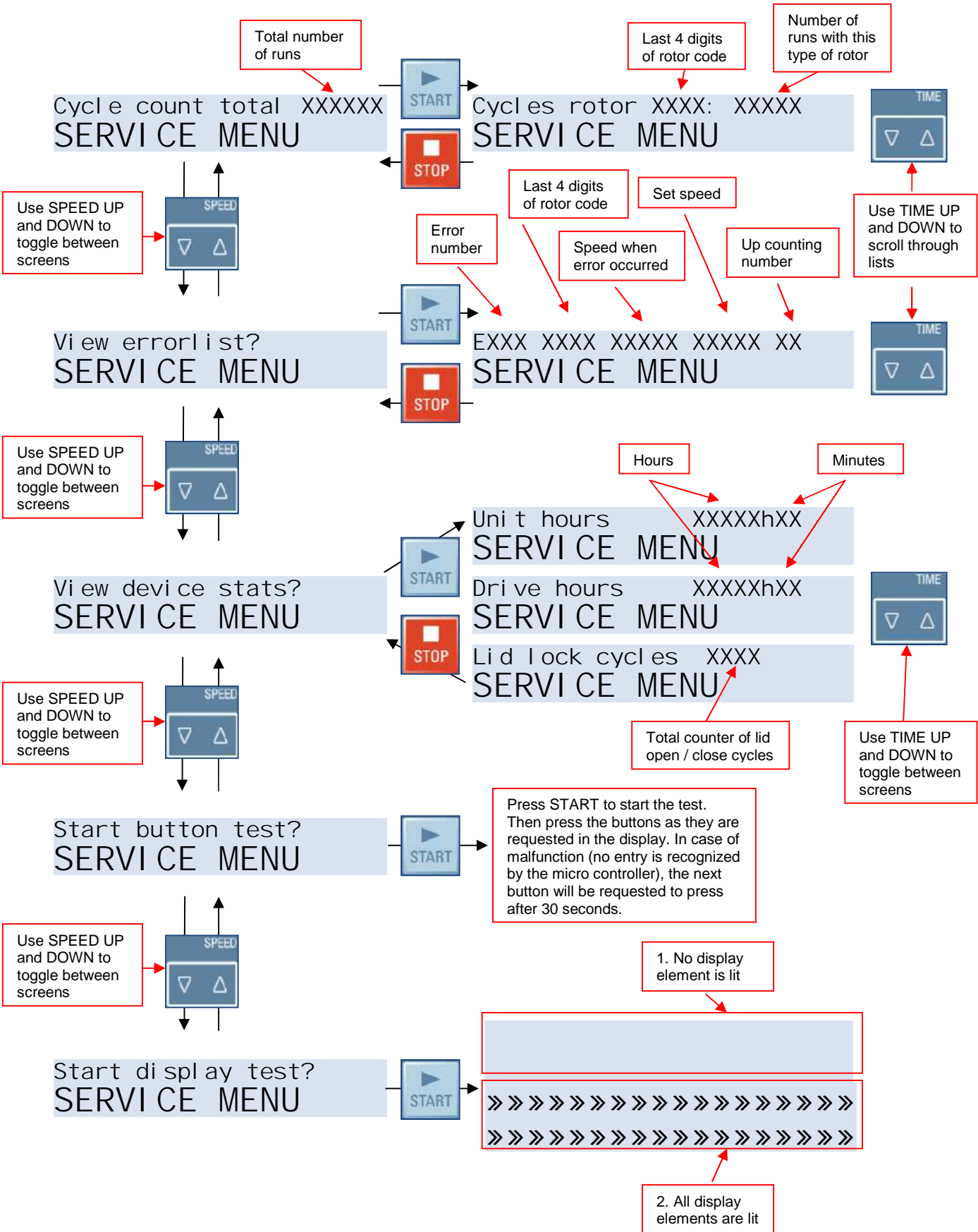
6. Use  to scroll through the menu.

See page 2-17 for complete menu structure.

System menu structure



Service menu structure



Imbalance Behavior

- Install a rotor from the table below in unloaded condition (without adapter or other inserts)

Rotor	Rotor name	Run through weight (grams)	Cut off weight (grams)
75005701	TX-150 Rotor	10	20
75005702	TX-150 Round Bucket	10	20
75005703	TX-150 Oval Bucket	10	20
75005704	TX-100S	10	20
75005635	TX-100	10	20
75005706	M-10 Rotor	10	30
75005637	MT-12 Rotor	4	12
75005600	HIGHConic Rotor	10	30
75003623	CLINIConic Rotor	10	30
75005719	MicroClick 30x2 Rotor	4	12
75005715	MicroClick 24x2 Rotor	4	12
75003473	Hematocrit Rotor	1 capillary	6 capillary
75005643	PCR Strip Rotor 8x8	4	8

- Insert rotor dependent **cut-off weight** in all buckets or Sample holders one after the other. The centrifuge must show an “Imbalance” message and stop.
- Insert the **run through weight** in the same manner, the centrifuge must run through 4 times to maximum rotor speed without giving an alarm.
- Always use a weight which can be placed at the bottom of the bucket or sample holders (e.g. screw nuts and flat washers with cable tie)

Cleaning of Instrument Parts

ATTENTION - WARNING!

The electrical and electronic components must not be cleaned with moist detergents!

For Cleaning the centrifuge housing or its accessories see user manual.

- **Electronic components**

Clean dusty components carefully with a dry and soft brush and remove loose dust with a vacuum cleaner.

- **Fans (refrigerated units only)**

Scratch off carefully with a knife or similar tool the crusted dirt from the fans' blades. Resulting grooves or marks must be removed subsequently with a fine abrasive cloth. Loose dirt is to remove with an absorbent cloth or vacuum cleaner.

- **Vent holes**

Remove dust and dirt from the vent holes of the unit und clean the condenser (refrigerated units only) using a brush and vacuum cleaner.

Electrical Safety Check

ATTENTION!

A final electrical safety check must be performed after each maintenance and/or repair!

- **Resistance check of protective conductor**

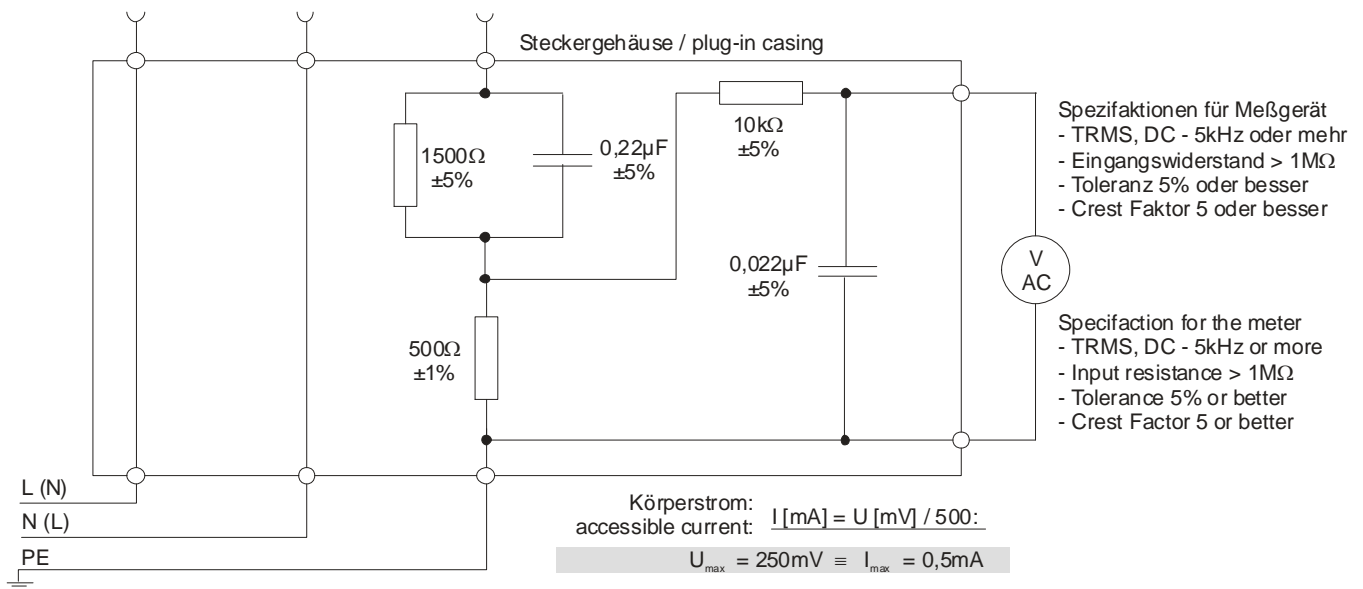
The measuring value of the resistance between the mains plug's grounding pin and the grounding conductors of the motor, electronic chassis and the casing must not exceed 200mΩ
Caution!

- **Insulation resistance check**

Check also the insulation resistance between the poles of the mains plug and the grounding conductor; the resistance value must be more than 2 MΩ

- **Accessible current measured to IVD medical equipment regulation**

The accessible current must not exceed **0.5 mAmps** in single fault condition (interrupted protection earth wire)!



FUNCTIONAL DESCRIPTION

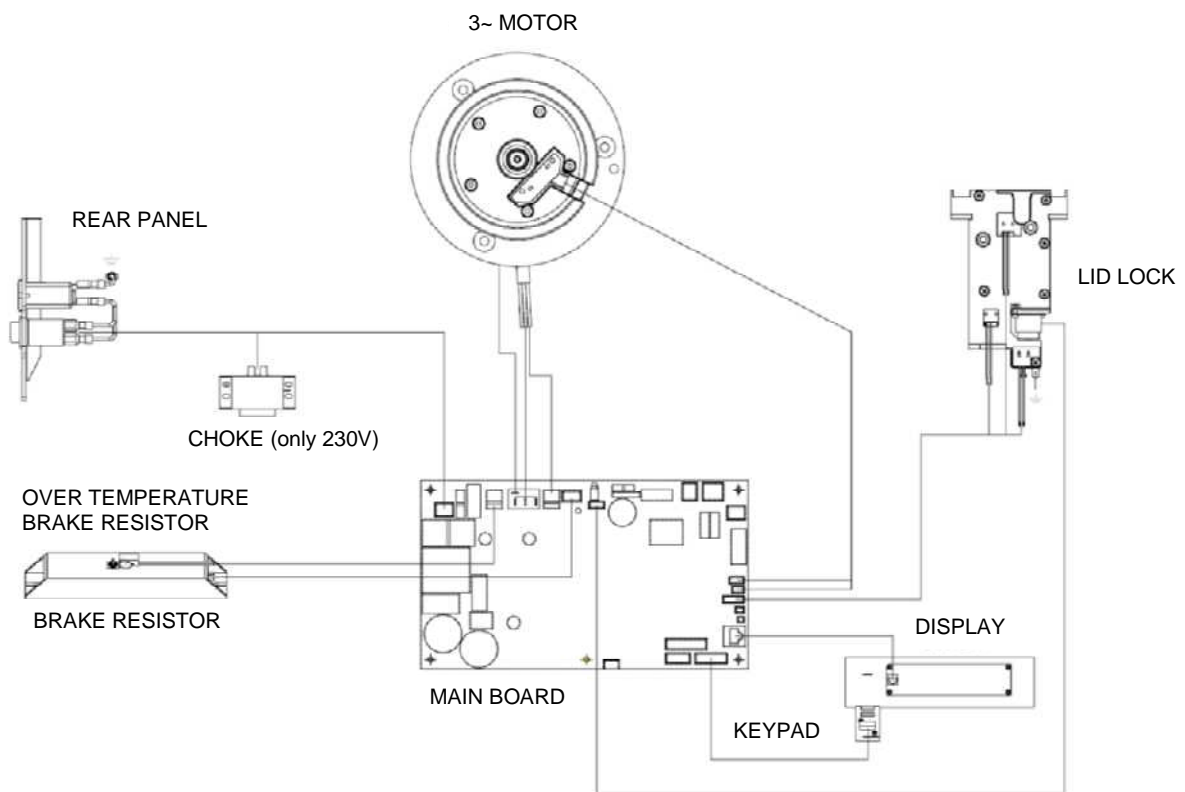
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Power Pack	3-4
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Brake Path	3-4
Frequency Converter	3-4
Micro Controller	3-4
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Display	3-5
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Speed Detection, Rotor Recognition, Imbalance Detection	3-5
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Lid Lock System	3-5

Block functions

The Megafuge 8 / ST8 / SL8 is a non-refrigerated laboratory tabletop centrifuge with microprocessor control, noise reduced induction drive motor and automatic rotor, speed and imbalance detection.

The unit is equipped with following boards and components:

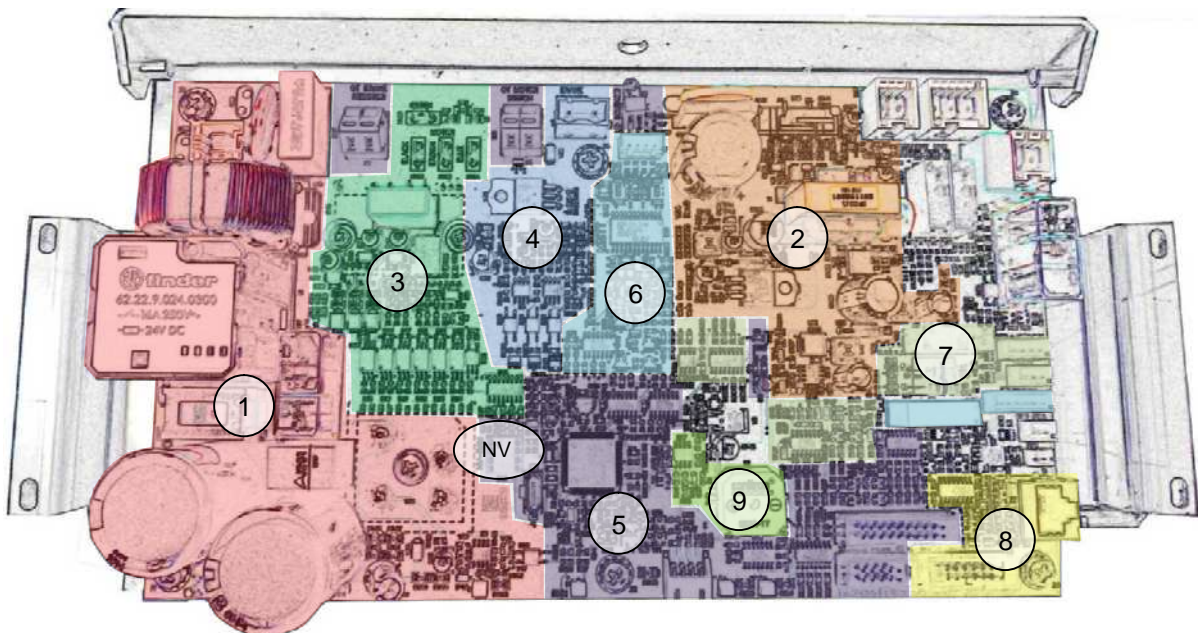
- Instrument socket with inlet filter for mains cable
- Two poles mains switch with integrated thermal over-current release (230V: 5A, 120V: 10A)
- Harmonic choke (230V units only)
- Main board with microprocessor part and power electronics
- Backlit liquid crystal display
- Overlay keypad
- Motor cover with sensor board incl. speed, rotor and imbalance detection
- 3 phase induction motor with integrated thermal over temp. cut out (C. O. 150°C)
- Lid lock with motorized opening and emergency release
- Brake resistor with over temp cut out



Main Board Functions

The **Main board** is mounted on an aluminum swivel chassis in the front of the centrifuge behind the front panel. The components on the main board are arranged in following function blocks:

- Noise filter and power pack for DC intermediate circuit with line voltage configuration (1)
- Power pack for low voltage supply of microprocessor part (2)
- Frequency inverter equipped with automatic loading (3) and voltage (brake) controlling circuits (4)
- Microprocessor part with CPU and NV RAM (5)
- Lid lock control circuit with driving component for lid latch stepper motor (6)
- Speed, imbalance and rotor detection circuit (7)
- Display and keypad control circuit (8)
- Buzzer circuit (9)
- Exchangeable NV-Ram containing specific data of the unit (NV)
- Additional circuits for refrigerated models.



Power Pack

The power pack consists of 1 transformer, 2 rectifiers (single diode) and 2 voltage regulators. It generates the following low voltage levels:

- 5V VCC: By switched-mode regulator A8499
Supplies all processors and its electronic components on main board, keypad and display. The reference potential is GND.
- 24V: Unregulated
Drives the lid lock stepper motor and the buzzer, supplies the LCD and the relays K1, K2, K3 and K4.
The reference potential is GND.
- 15V: By voltage regulator LM317
For protection circuit. **CAUTION: The reference potential is U-**

Intermediate Circuit

The DC intermediate circuit serves as an energy store between the AC power input and the transmitted motor performance. The intermediate circuit consists of a line voltage selection switch, a heat-sink-cooled bridge rectifier and two reservoir capacitors which are charged whenever the centrifuge lid is closed (K1 activated). The presence of the DC voltage is indicated by LED V41. When switching the unit off, the DC voltage of the intermediate circuit is discharged across a path of resistors.

Brake Path

Electrical power is fed back into the intermediate circuit during motor deceleration (motor acts as generator). This braking power is transformed into heat by the connected resistor so that the intermediate circuit voltage does not rise to an excessive level. The brake resistor is switched into the intermediate circuit by a fast switching transistor (pulse-width modulation, synchronised by the double mains frequency). This transistor is voltage dependent controlled by a self-acting stage (closed loop).

Frequency inverter

The 3-phased motor is provided with chopped direct voltage blocks (chopped frequency approx. 5kHz, amplitude is height of DC intermediate voltage). These blocks are variable in frequency and pulse-width modulation, 120° de-phased. These 3 phases are controlled during acceleration, running at set speed and deceleration (e.g. for small speed: low frequency and small pulse-width length will be affected). The frequency inverter is protected against over current, over temperature and over-voltage.

Microcontroller (Central Processing Unit) Part

The controller block includes the central processor unit (CPU) LPC1764 programmed with software to control the centrifuge and a data storage (NV-RAM). Current versions and revisions of software and data can be seen in the system menu.

Software is loaded into the LPC1764 via a serial interface on the main board X6 and cannot be upgraded in the field. The NV-RAM data can be updated by replacing the entire NV-RAM with one of the latest revision.

NV-RAM data includes rotor parameters, such as max speed and g-force, acceleration and deceleration profiles and imbalance behaviour.

Display

The LCD is attached to the front panel. The connection to the main board is done by a RJ45 cable. Data transfer as well the low voltage supply of 5V is verified. The operating keys are managed by an own connection.

Speed, imbalance and rotor detection

The motor cover contains the detection circuits for speed, rotor and imbalance. The LED V11 on the main board indicates the function of the speed and rotor detection. A measurement of the signal is not possible.

Rotor detection

4 magnets mounted on each rotors bottom are detected by a Hall Effect sensor in the motor cover. The magnets are alternately arranged in polarity on a ring around the rotors centre. The gap between 2 magnets varies with different rotor types, but is at least 20°.

The magnets are switching a flip-flop stage by which different pulse lengths and pulse intermissions are generated during one rotor rotation. By this signal the CPU is able to detect up to 65 different rotors and the correct direction of rotation, too.

After the rotor has been recognized this signal is used for the redundant speed measurement.



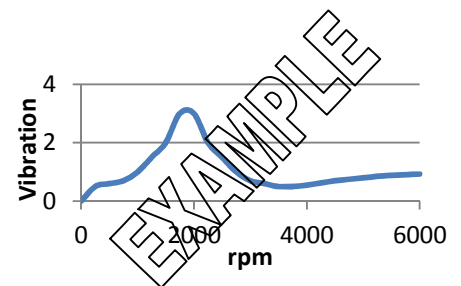
Speed detection

A Hall Effect sensor in the rotor cover counts the passing by magnets. As the 4 magnets are arranged alternating in polarity, 2 north and 2 south poles make one revolution.

For safety reasons the speed detection circuit is redundant and the rotor detection circuit is used to detect the speed, too, after the rotor has been recognized.

Imbalance detection

After the rotor has been recognized, the depending vibration curve is loaded from the NV-RAM. If vibration, which is detected by an accelerometer in the motor cover, exceeds this curve, an imbalance alarm is triggered by the CPU.



Lid lock system

The lid is closed by pressing the hook into the latch. Two micro switches monitor the correct position of the hook and the emergency opening during the run. An alarm is triggered if one of these two micro switches opens, while the rotor is spinning.

The latch is unlocked by a bi-directional stepper motor controlled by a stepper motor driver on the main board. A micro switch is used for the 0-position finding after each opening and at power on.

For additional safety the motor driver is de-activated by a relay when the speed is above 120rpm.

ELECTRICAL DIAGRAMS

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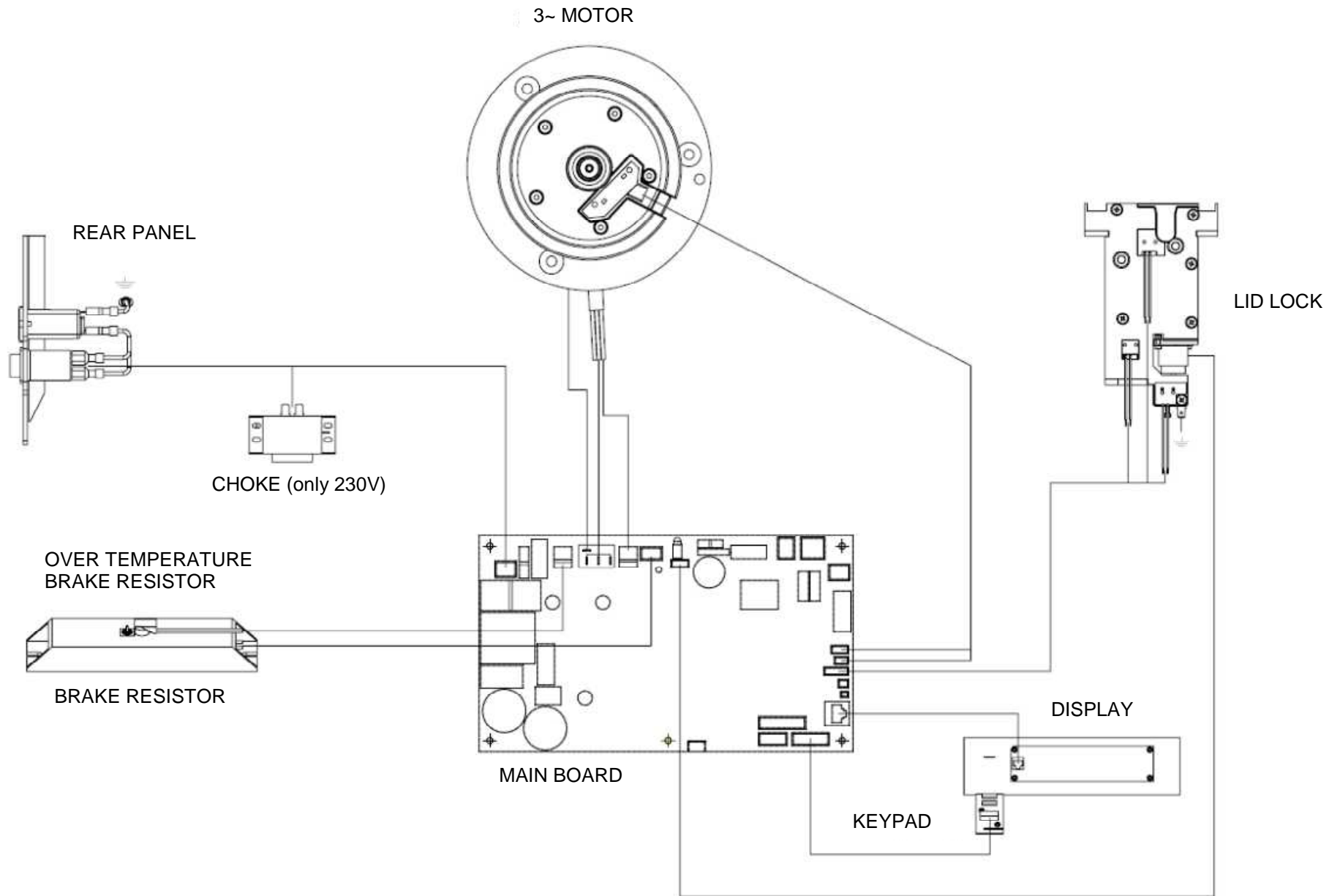
Protection Circuit	4-6

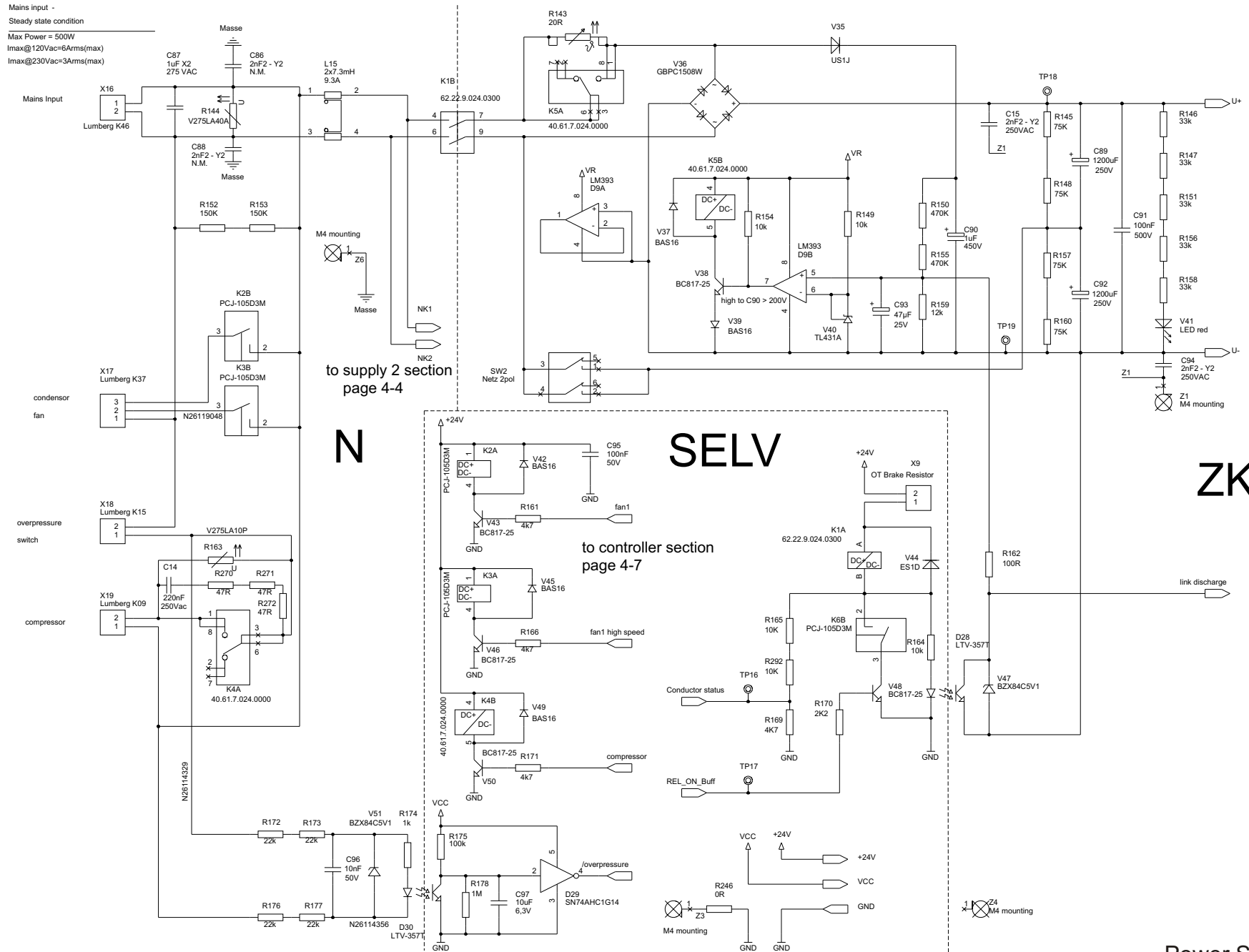
Controller	4-7

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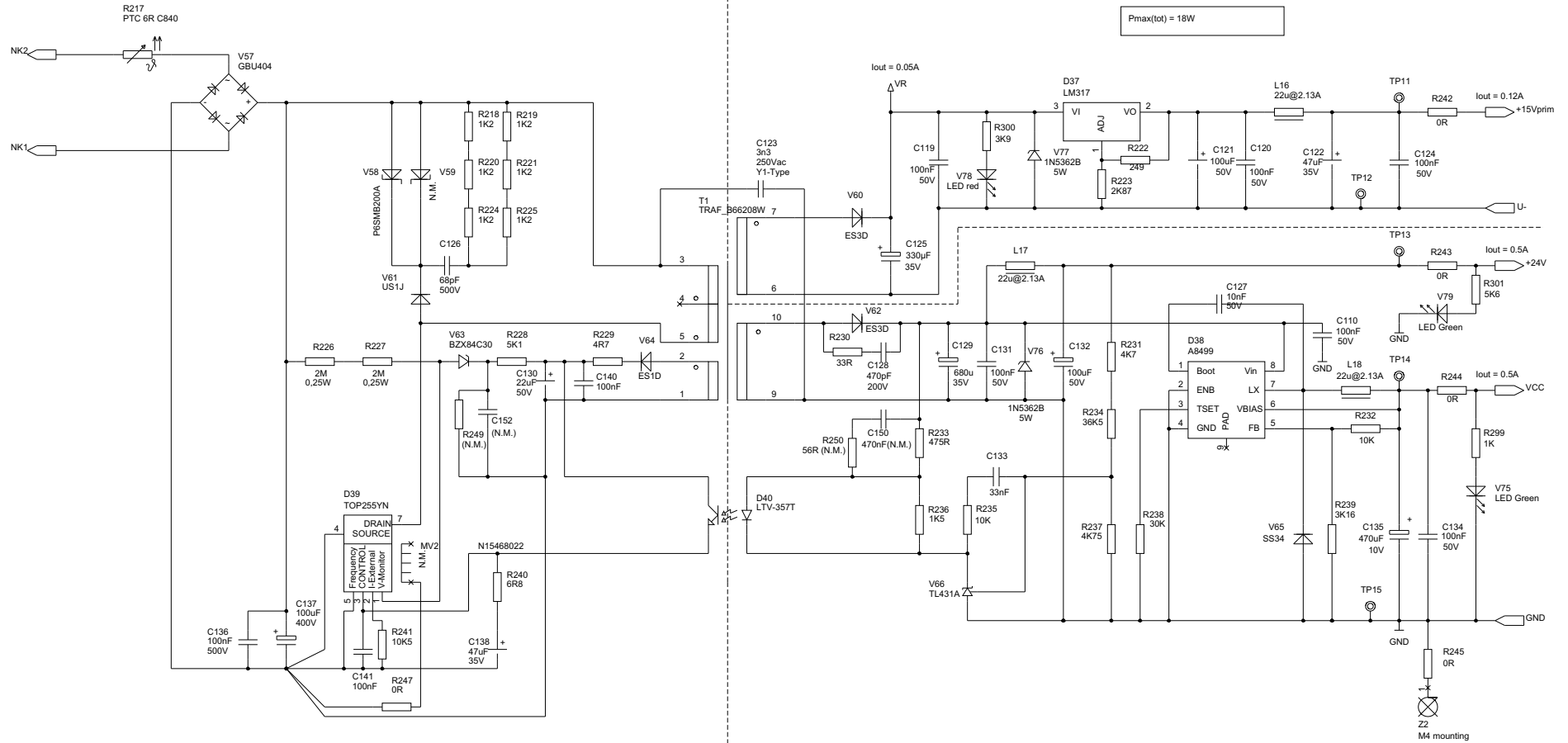
Discharge your body before touching electronic components!



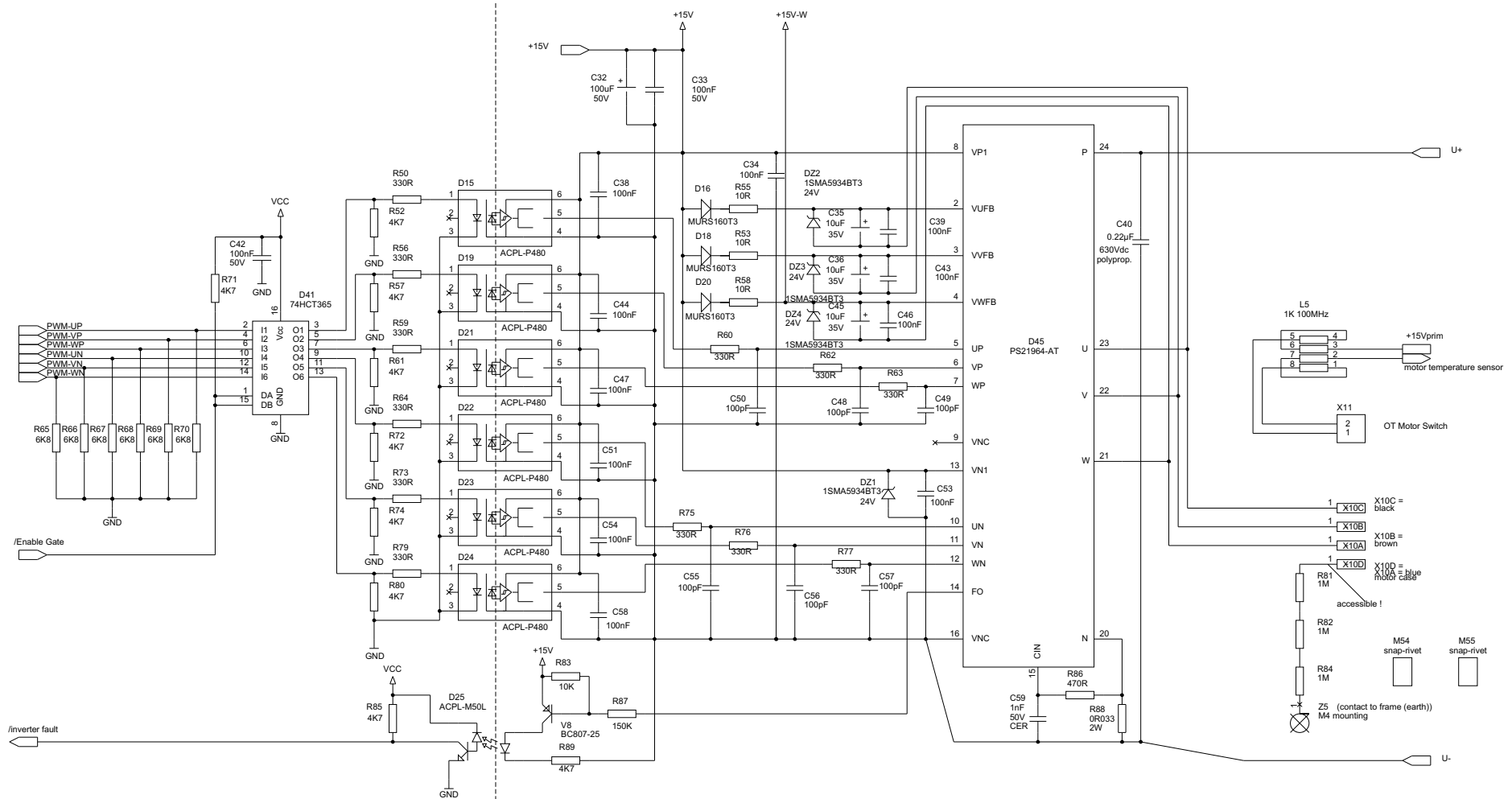


N ZK

Pmax(tot) = 18W

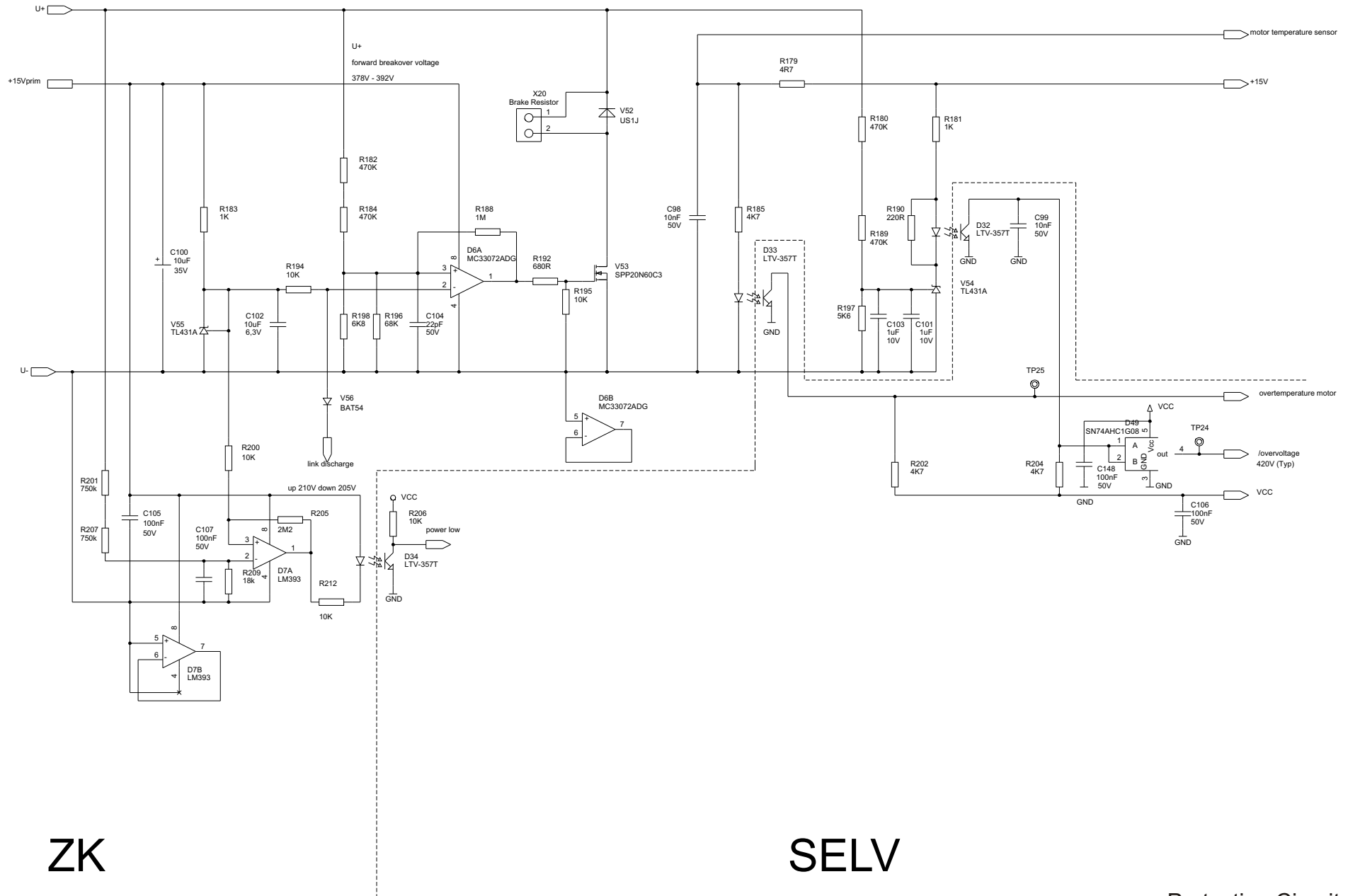


SELV



SELV

ZK

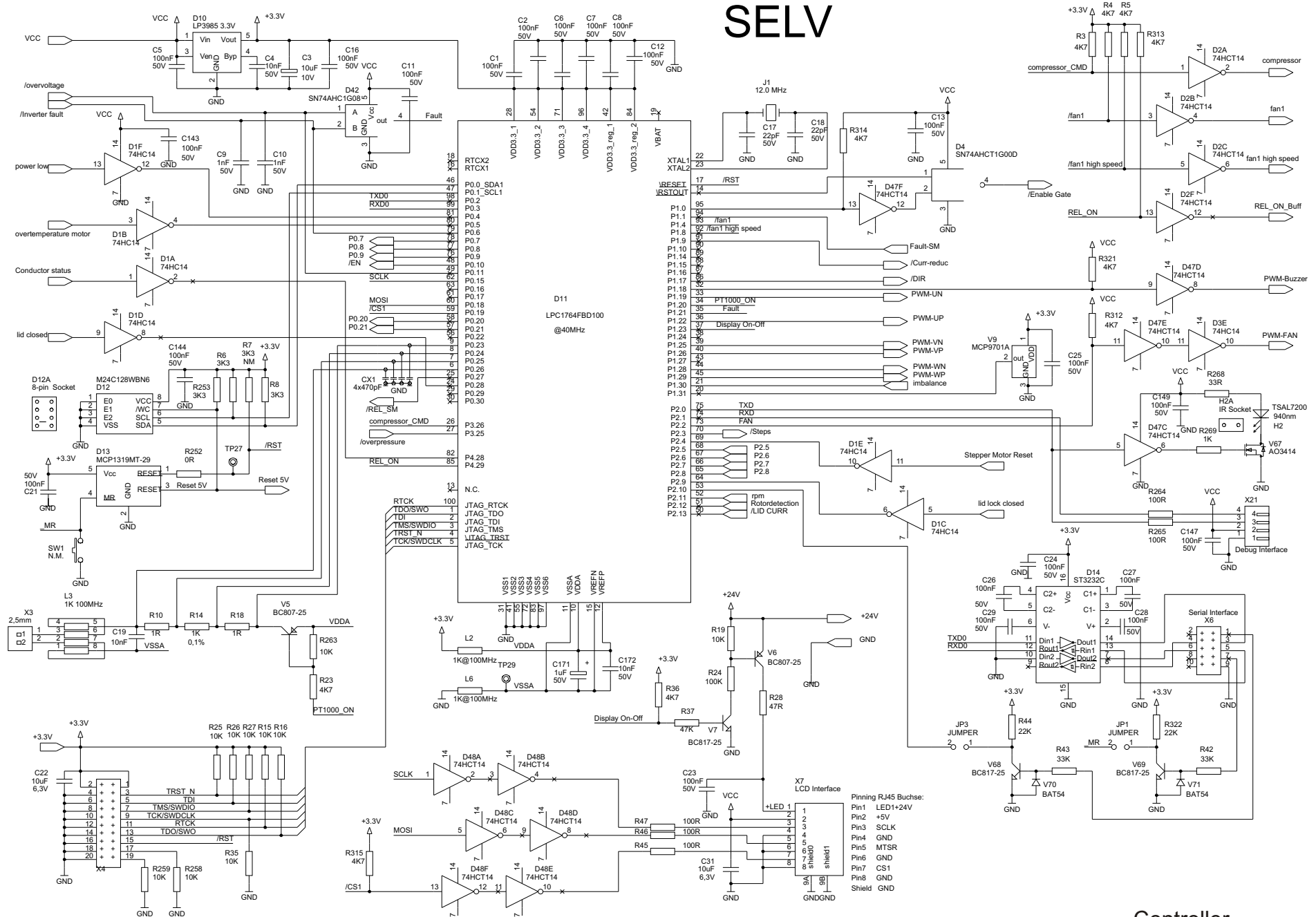


ZK

SELV

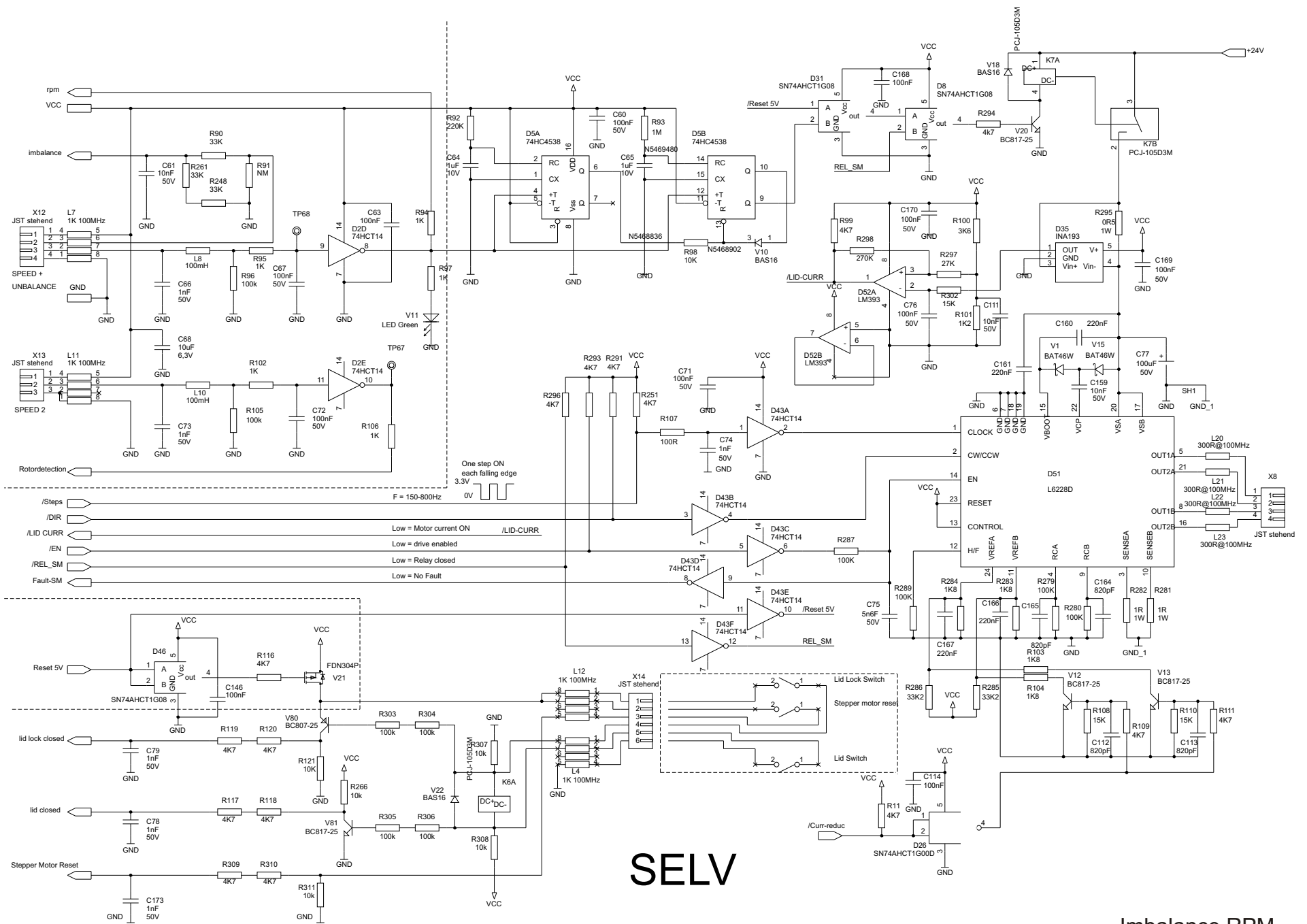
Protection Circuit

SELV



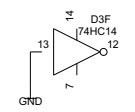
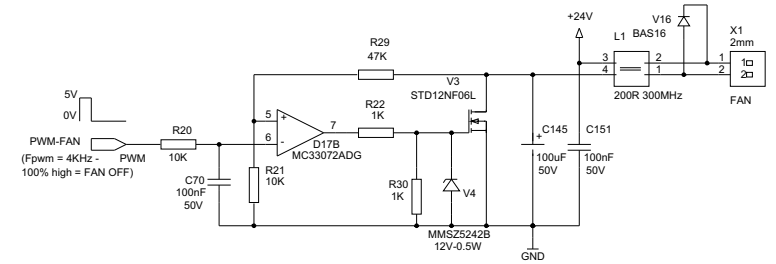
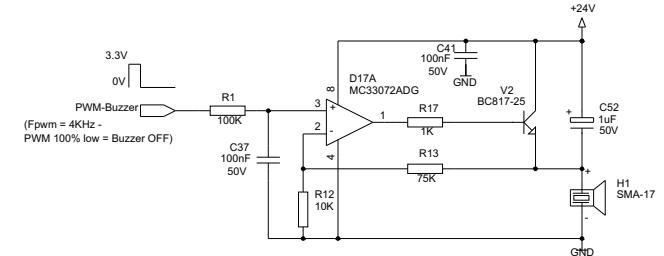
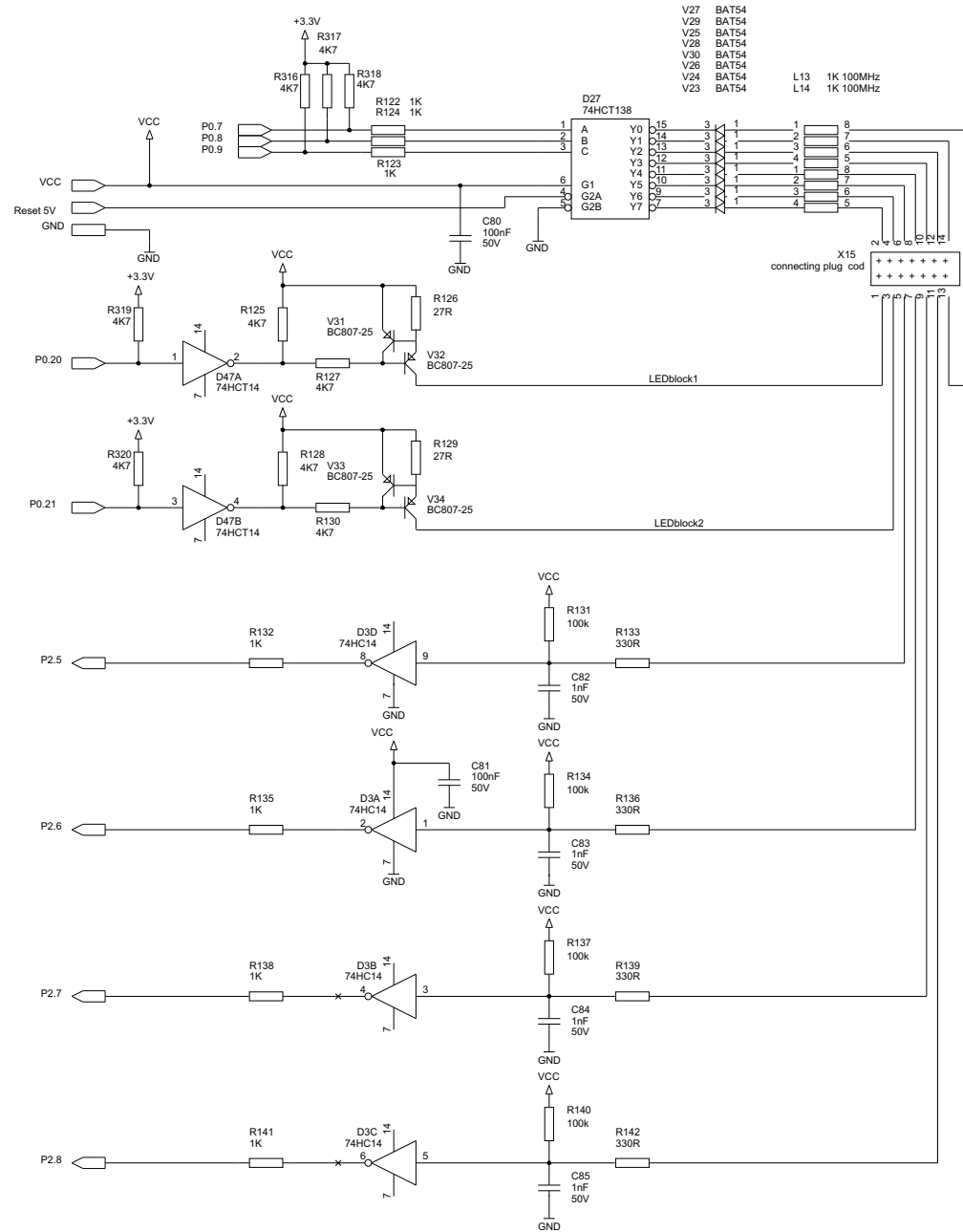
Controller

- Pinning RJ45 Buchse:
- Pin1 LED1+24V
 - Pin2 +5V
 - Pin3 SCLK
 - Pin4 GND
 - Pin5 MTSR
 - Pin6 GND
 - Pin7 CS1
 - Pin8 GND
 - Shield GND



SELV

Imbalance RPM



Key Control

DISASSEMBLY OF INSTRUMENT PARTS

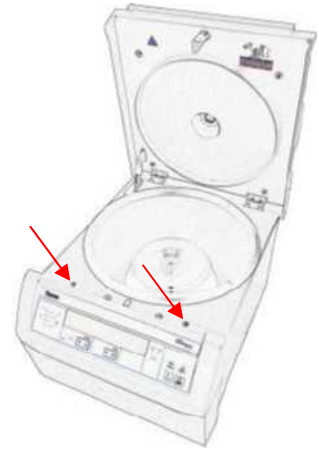
Disassembly of Mechanical Parts	5-2
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Removal of AutoLock	5-7
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Checking the AutoLock	5-8

Before disassembling any parts, switch off the unit and pull out the mains plug.

Disassembly of mechanical parts

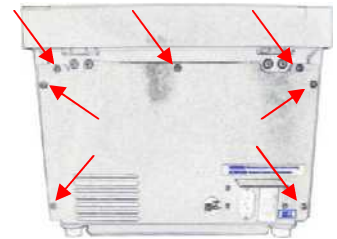
Front Panel

Open the lid, switch off the unit and pull out the mains plug
 Remove the 2 screws on top of the front panel
Pull the front panel up and lift it off.
 Disconnect wiring from display and overlay adaptor board



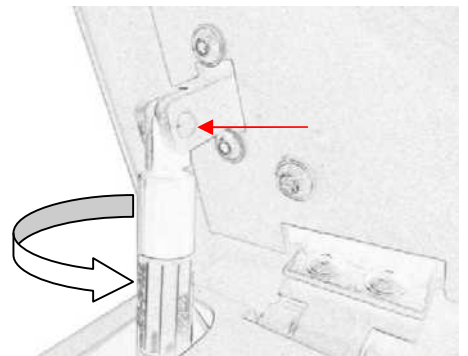
Back panel

Switch off the unit and pull out the mains plug.
 Remove the 7 screws attaching the back panel to the casing.
 Tilt the panel down and unplug the cables.



Gas lid stay

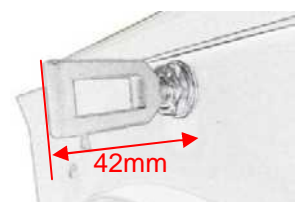
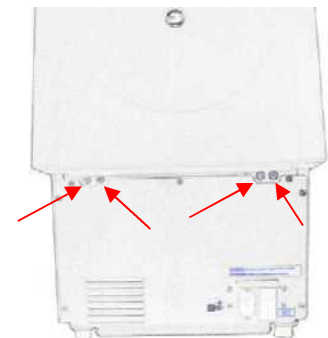
Open the lid
 Remove the cotter pin from the joint block with help of a striker pin and a hammer.
 Unscrew the gas lid stay from its bottom holder counter clockwise.
 Take out the gas lid stay to the top.



Lid

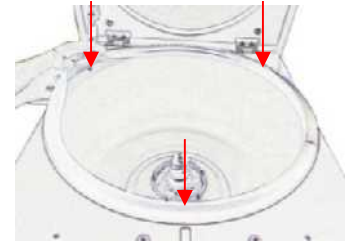
Open the lid, switch off the unit and pull out the mains plug
 Remove gas lid stay from top joint block
 Remove the 4 screws attaching the lid hinges to the main frame.
 When reassembling the lid take care that the lid bolt fits the casing hole centric.

The lid hook must be adjusted to a visible length of 42mm.



Gasket

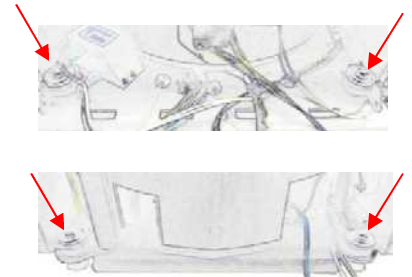
Remove the 3 screws hidden by the gasket that are attaching the inner bowl and the gasket to the outer casing.
Slightly lift the bowl together with the gasket and take the gasket of the bowl.

**Bowl**

Remove the AutoLock head from the motor.
Remove the sensor cover.
Remove the 3 screws hidden by the gasket that are attaching the bowl to the outer casing.
Lift the bowl out to the top.

Casing

Remove the front panel.
Remove the back panel.
Remove the main board.
Remove the AutoLock head and the sensor cover.
Remove the bowl.
Remove the 4 screws attaching the casing to the bottom plate.
Lift the casing off.



Replacement of electrical components

NV-RAM on the main board

Before replacing the NV-RAM enter the system menu and note the version and revision number.

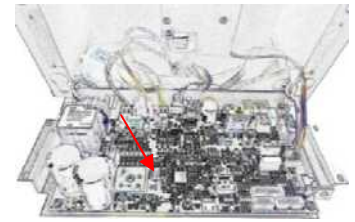
Remove the front panel.

Remove the 4 screws at the swivel cassis and flip down the main board.

ATTENTION - Discharge your body before handling CMOS components!

Use a chip removal tool or a small screwdriver to pull the NV-RAM out of its socket.

After reassembly check the version and revision number of the new NV-RAM in the system menu.



Main board

Remove the front panel.

Remove the 4 screws at the swivel cassis and flip down the main board.

Disconnect all plugs and cables.

Remove the 2 screws attaching the swivel chassis to the casing.

ATTENTION - Discharge your body before handling CMOS components!

Remove the NV-RAM and place it on the new main board – new main boards are delivered without or with an empty NV-RAM.

ATTENTION - When installing a new main board, make sure that the voltage selection switch is set to the correct voltage!



Lid latch

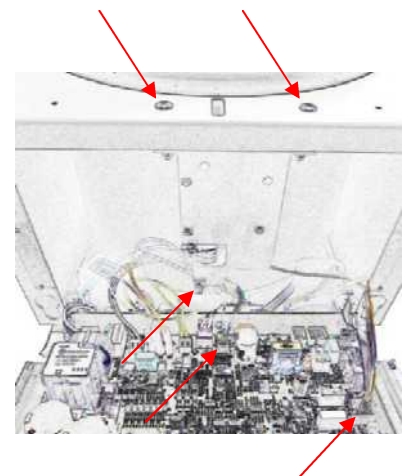
Remove the front panel.

Remove the 4 screws at the swivel cassis and flip down the main board.

Disconnect the micro switches and the stepper motor from the main board (X14 and X8) and the grounding wire from the latch.

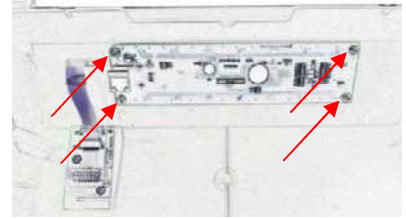
Remove the two screws attaching the latch to the casing.

When reinstalling the latch align it in a way that the lid hook moves in and out smoothly.



LCD

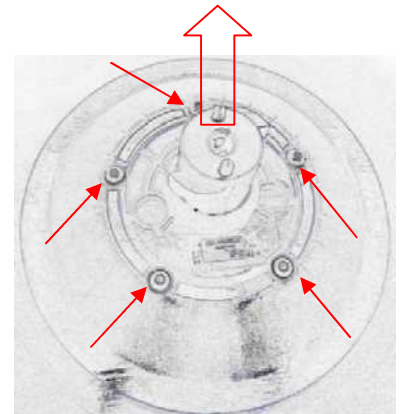
Remove the front panel.
Remove the 4 screws attaching the LCD to the front panel

**Keypad**

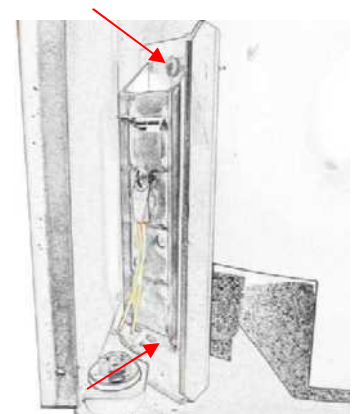
Remove the front panel.
Disconnect the overlay from the overlay adaptor board.
Use a screwdriver, knife or similar to remove a corner of the overlay from the front panel. Pull the overlay off.
Clean the surface of the front panel from all glue remainders.

**Sensor cover with speed, imbalance and rotor detection**

Open the lid.
Remove the front panel and flip down the main board.
Disconnect the sensor cover from the main board (X12 and X13).
Remove the AutoLock head from the motor.
Remove the 5 screws attaching the sensor cover to the motor.
Attach a string to the cables before pulling them through.
Remove the sensor cover.
Use the string to pull the cables of the new sensor cover through.

**Brake Resistor with over temp. cut out**

Remove the front panel and flip down the main board.
Disconnect the brake resistor and its over temp. cut out from the main board (X20 and X9).
Remove the back panel.
Remove the 2 screws attaching the brake resistor to its holder.
Attach a string to the cables before pulling them through.
Remove the brake resistor.
Use the string to pull the cables of the new brake resistor through.
After reassembly check the function of the brake resistor during a short test run (resistor must heat up during braking – CAUTION it may be hot!).



Replacement of drive components

Drive motor

Open the lid.

Remove the front panel and flip down the main board.

Disconnect the motor and its over temp. cut out from the main board (X10 and X11).

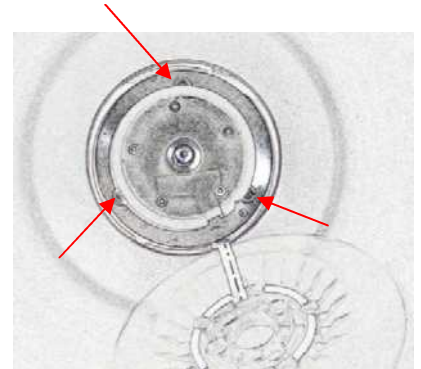
Remove the AutoLock and the sensor cover. It is not necessary to pull out the ribbon cable of the sensor cover.

Remove the 3 nuts mounting the motor to the anti vibration mounts.

Attach a string to the cables before pulling them through.

Remove the motor.

Use the string to pull the cables of the new motor through.



Anti vibration mounts

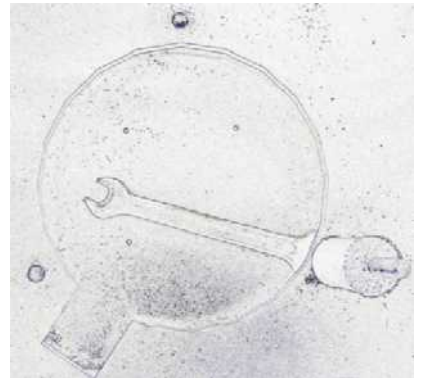
Open the lid.

Remove the AutoLock, sensor cover and motor.

It is not necessary to pull out the ribbon cable of the sensor cover and the motor cable.

Loosen the anti vibration mounts with a 10mm spanner from the top. It is not necessary to access the screws from underneath the centrifuge.

Always replace all 3 anti vibration mounts and their sand paper discs together.

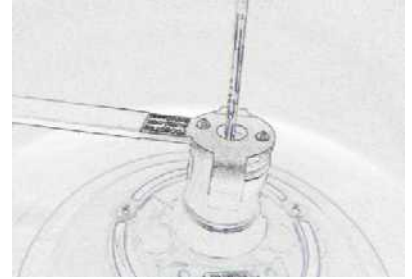


Removal of AutoLock

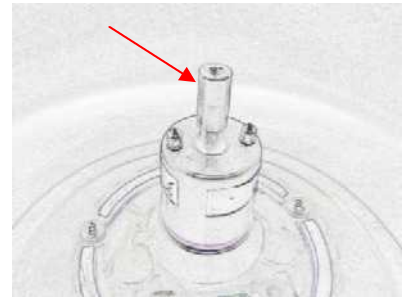
This work requires AutoLock tool kit 70904693 or similar tools.

Removal of AutoLock

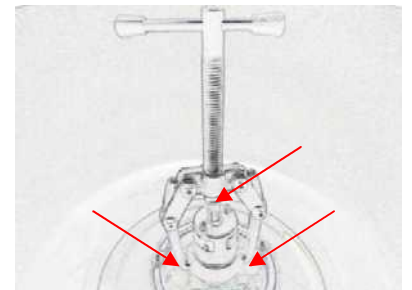
Loosen the screw in the center of AutoLock head 4 turns using a 3mm Allen key and the AutoLock key supplied with the tool kit.



Insert the centering pin.



Use the puller supplied with the tool kit to pull off the AutoLock from the motor cone.



Loosen the center screw completely and remove the AutoLock.



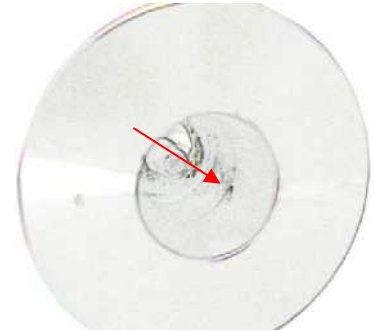
Removing stuck rotors

Remove stuck rotors by hitting the green AutoLock button with a hammer. Depending on the type of rotor the AutoLock may be removed first (fixed angle rotors only) and the AutoLock pin supplied with tool kit can be used instead.



Checking the AutoLock

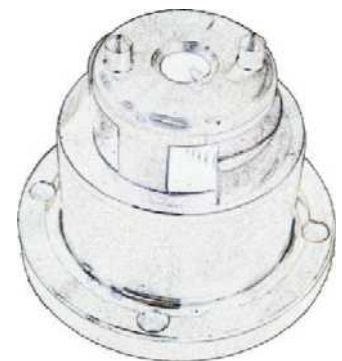
The inner and outer tapered surfaces of the Autolock must not show signs of damage such as scratches or dents.



The torque pins must not be bent.



Check the correct locking of the AutoLock with the adaptor supplied with the tool kit.



Check the correct un-locking with the adaptor and the AutoLock pin supplied with the tool kit.



CALIBRATION (REFERENCE MEASUREMENT)

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General	6-2

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Documentation	6-2
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Safety test	6-4

Documentation	6-5

Introduction

This chapter describes the calibration work to be performed on a yearly basis. A calibration certification form can be found in the attachment B-1.

General

Successfully completing the preventive maintenance checklist and calibration procedure as outlined will ensure that the instrument is properly maintained and calibrated to Thermo Scientific specifications.

Requirements

Equipment

- Optical (Laser) tachometer
- Stopwatch
- Weights according to rotor table
- Safety Tester

Note: Check calibration due date on all test equipment before starting the procedure.

Documentation

- Service manual
- Centrifuge operating manual
- Preventive maintenance checklist (A-1)
- Calibration certification form (B-1)
- Certification label
- Certificate of calibration for each piece of test equipment used to perform the calibration
- Training certificate

Preventive maintenance

- Perform preventive maintenance checks as outlined in the service manual to ensure the instrument is in good working order before performing any calibrations.
- Complete the preventive maintenance checklist. (A-1)

Calibration (reference measurement) procedure

Speed

Install a rotor and attach a piece of reflecting tape (or black tape on reflecting rotors) near the center of the rotor. Close the centrifuge lid.

Set the speed to 1000 rpm and start the centrifuge. When the display shows 1000 rpm wait for 10 seconds. Use an optical (laser) tachometer and measure the speed of the rotor through the window in the centrifuge lid. Record the measured speed and the displayed speed in the speed section of the certification form. Set the speed to rotor maximum. When the display shows the set speed wait for 10 seconds and measure the speed through the window. Record the measured speed and the displayed speed in the speed section of the certification form.

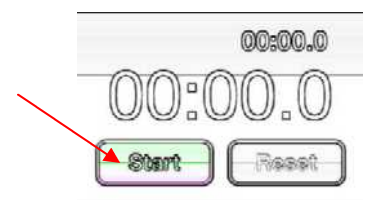
Determine whether the speeds recorded meet the specifications on the form. If the specifications are met, this test is finished. If the specifications are not met, replace the main board, as adjustments are not possible and repeat the test.

There is no possibility to measure the speed signal of the centrifuge itself!



Time

Install a rotor and close the lid. Set the speed to 1000 rpm and the time to 10 minutes. Start the centrifuge and the stopwatch at the same time. Stop the stopwatch when the time section of the display shows 0. Record the measured time in the time section of the certification form. Determine if the time value recorded meets the specifications in the form. If the specifications are met, this test is finished. If the specifications are not met, replace the main board, as adjustments are not possible and repeat the test.

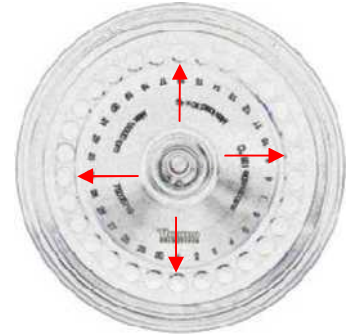


Imbalance

This test is only to be performed by a trained and authorized service engineer!

Refer to Service manual chapter 2 – “Imbalance behavior” for cut off and run through weight table.

Install a rotor. Place the rotor dependent cut off weight in one of the buckets / cavities and close the centrifuge lid. Set the speed to rotor maximum and press start. The centrifuge must shut off with an imbalance alarm sometime during acceleration. Repeat this test in 3 more positions, each displaced by 90°. Repeat the test with rotor dependent run through weight. Determine whether the cut off and run through weights meet the specifications in the service manual and record the rotor type, cut off and run through weight in the imbalance section of the certification form. If the specifications are met, this test is finished. If the specifications are not met, replace the main board, as adjustments are not possible and repeat the test



Safety test

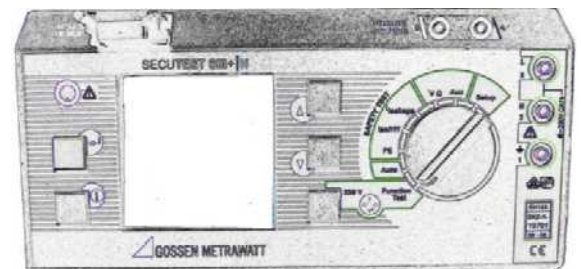
Perform an electrical safety test according to the instruction manual of the tester.

The test should consist of

- Grounding resistance check
- Insulation resistance check
- Earth leakage current check

Record the measured values in the safety test section of the calibration form

Determine whether the values recorded meet the specifications on the form. If the specifications are met, this test is finished. If the specifications are not met, check for missing grounding connections and / or faulty parts.



Documentation

After filling in the certification information complete the following documentation:

- Log test equipment data on calibration certification form.
- Review P.M.checklist and calibration certification form to ensure that all data and required information has been recorded properly.(including your signature and date)
- Fill out a certification label and place it on the right side of the centrifuge where visible or at a location selected by the customer.
- Ask the customer to sign the calibration certification form and place a copy in the customer's Certification Record Book for that centrifuge.
- Place copies of the P.M.checklist and Field Service Report in the same Record Book.
- Provide copies of your training certificate and test equipment calibration certificates if requested by the customer.

SPARE PARTS

Front Panel	7-2

Front View	7-3

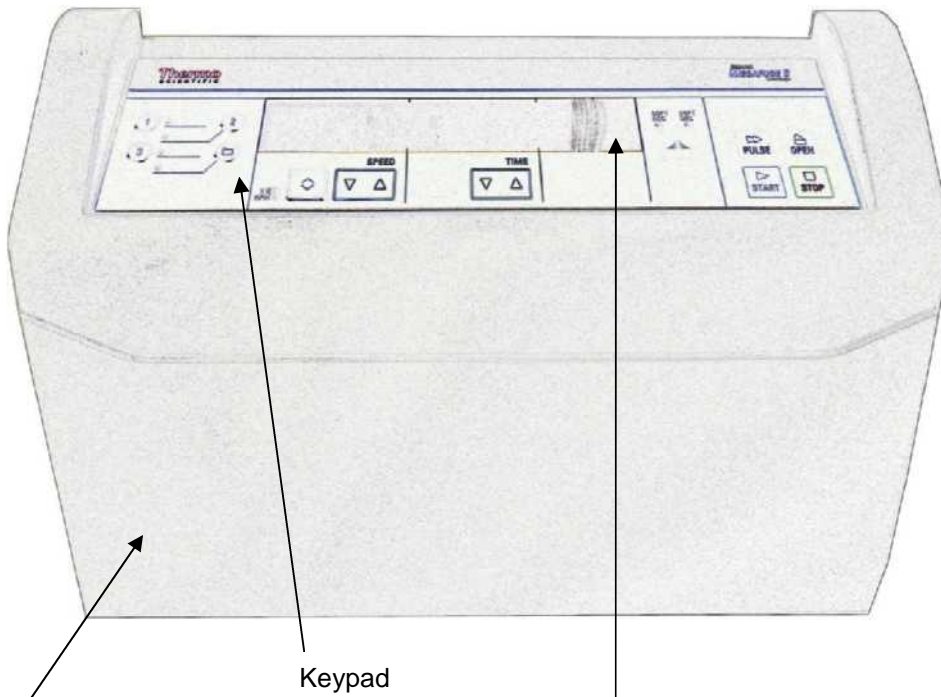
Back View	7-4

Top View	7-5

Drive	7-6

Spare part numbers and spare parts are subject to change in case of technical upgrades or supplier change. New specifications and part numbers are announced through technical service bulletins.

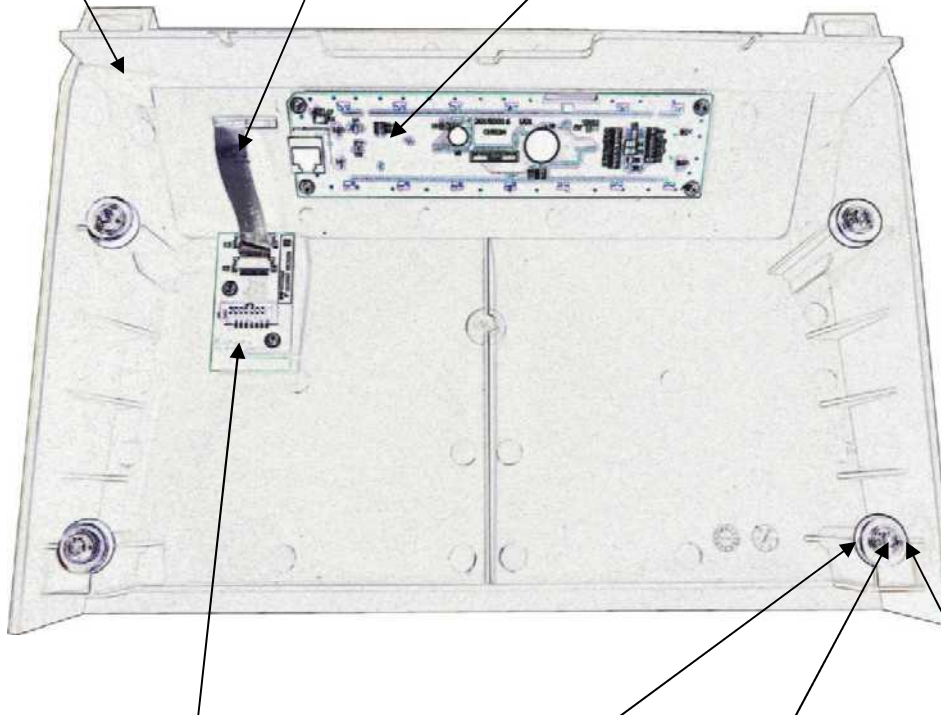
Front panel



20059014
Front panel

Version	Part number
Heraeus	20059701
Sorvall	20059703
Thermo	20059705

20150316
Display



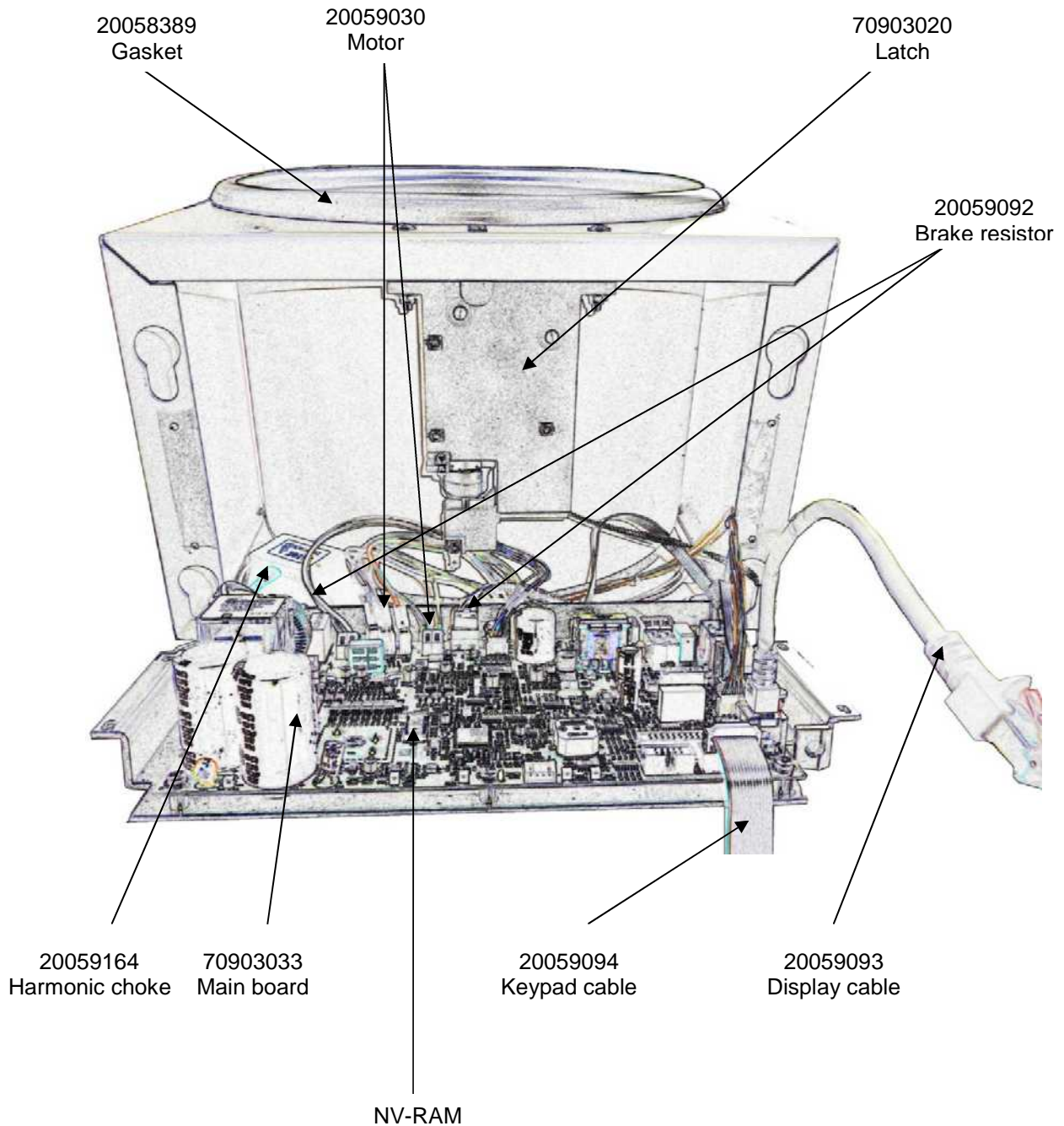
20150285
Keypad adaptor

20290706
O-Ring

20480320
Screw

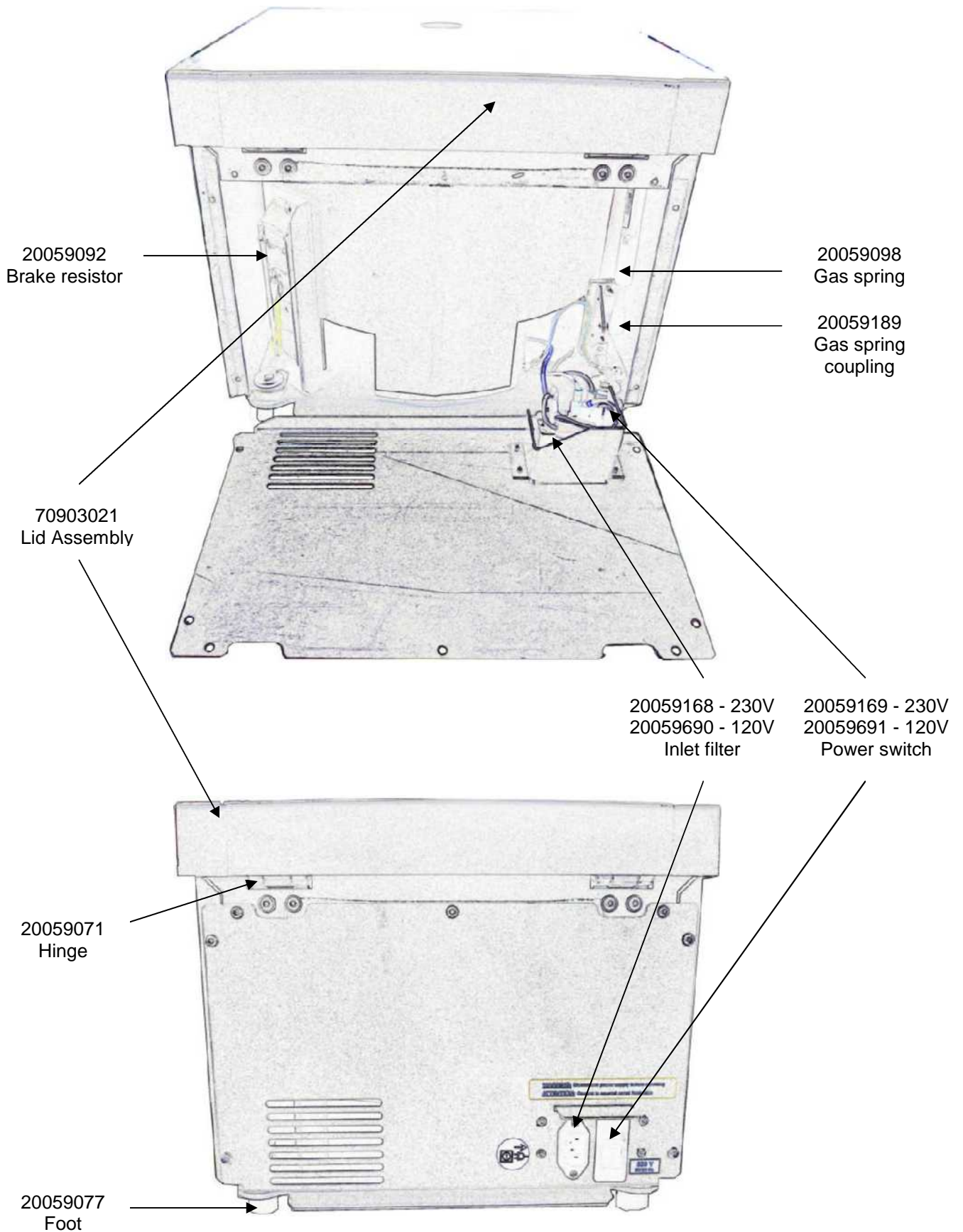
20480317
Washer

Front view

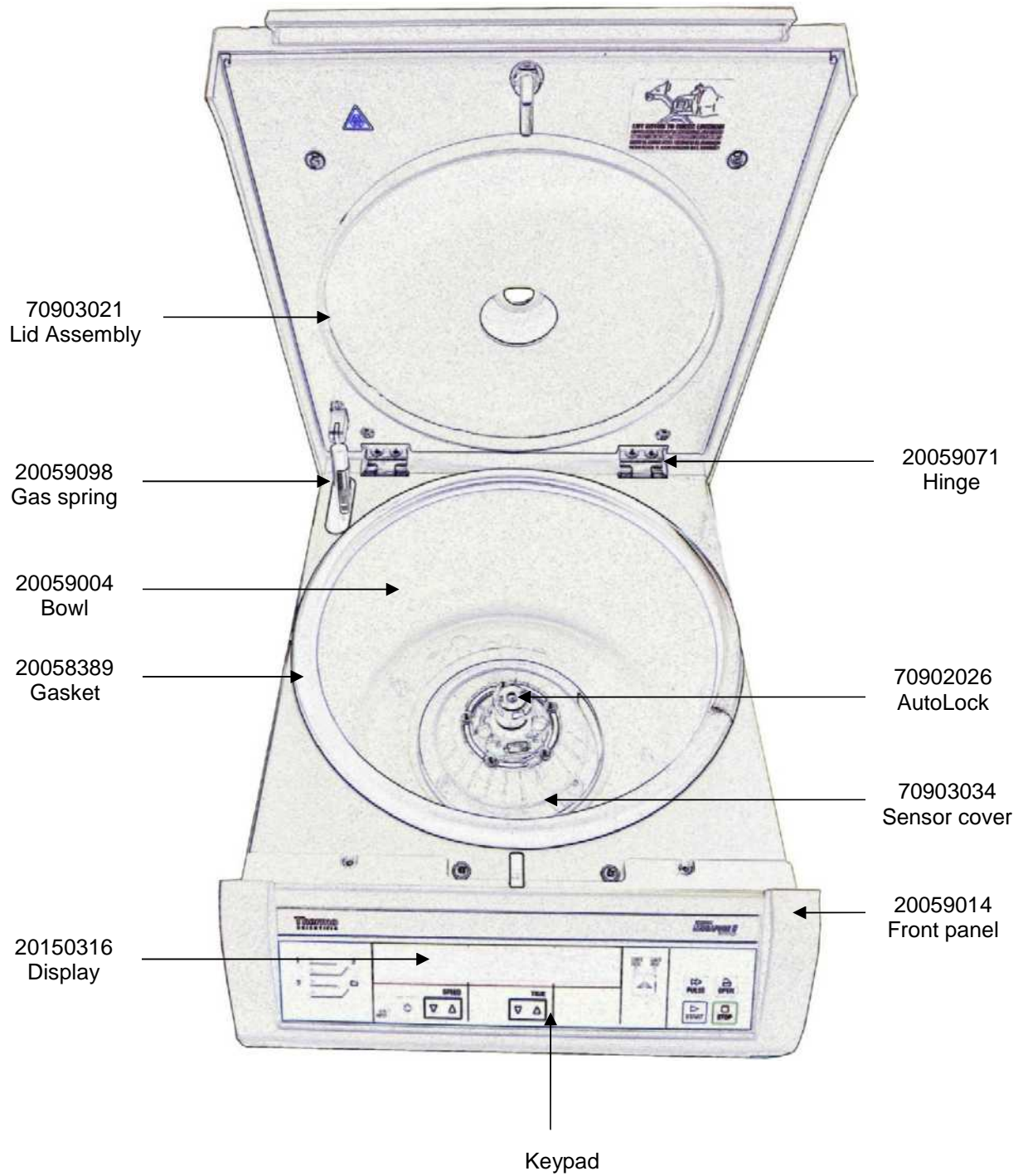


Version	Part number
230V	70904751
120V	70904753
100V	70904755

Back view

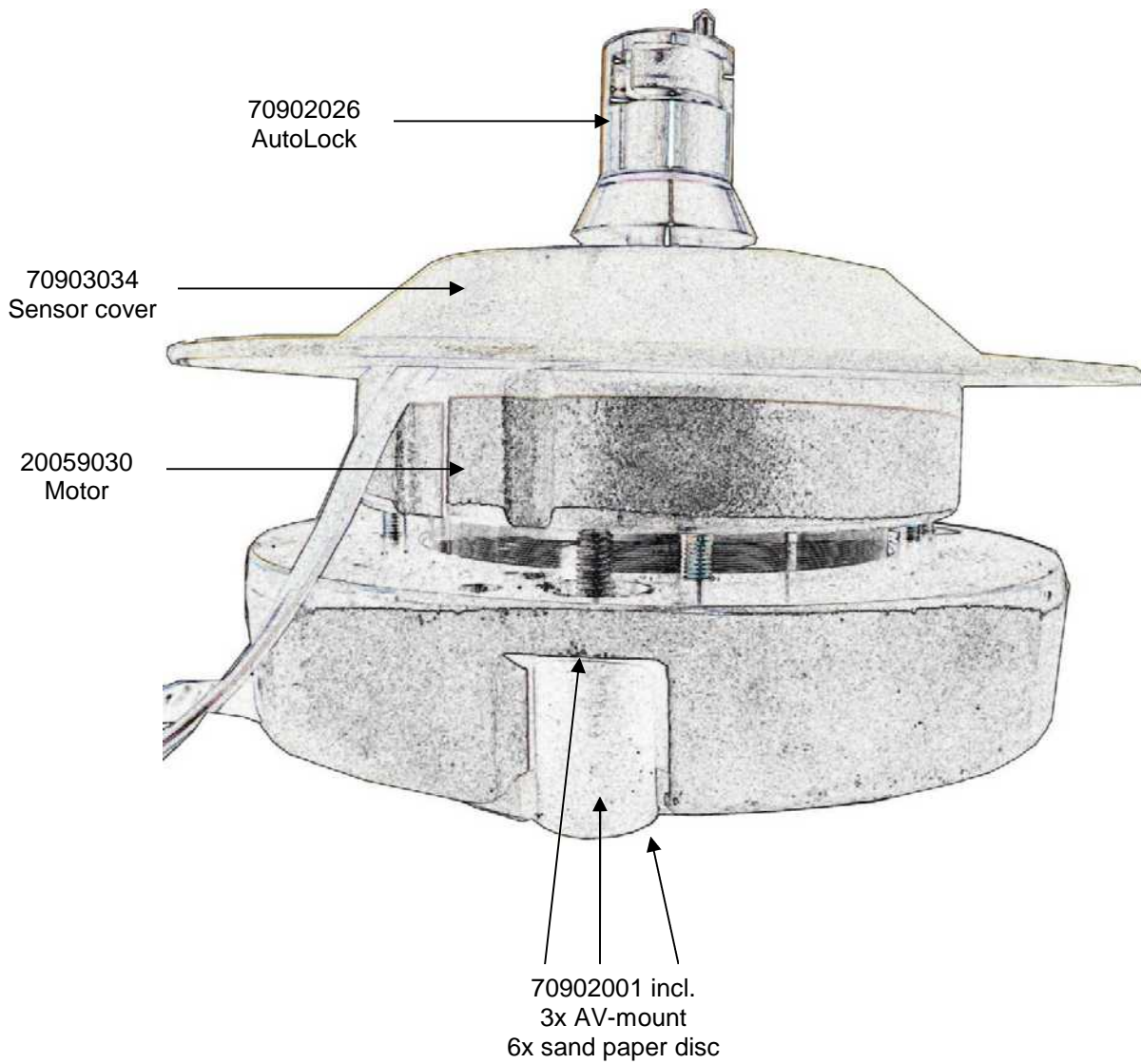


Top view



Version	Part number
Heraeus	20059701
Sorvall	20059703
Thermo	20059705

Drive





Preventive maintenance checklist

Megafuge 8
SL8 / ST8

Account name:	Account address:
Instrument model:	Serial number:
Report number:	Date:

Maintenance without dismantling the centrifuge

Acceptance criteria	Pass	Fail
Electrical installation		
Supply voltage and main power fusing meets specifications (data plate)		
Instrument plug and wall socket in good condition		
Power cord insulation not damaged		
Instrument socket not damaged		
Comments:		
Location and mechanical installation		
Base resonance-free and stable		
Safety clearance around instrument of 30 cm		
Centrifuge level		
Comments:		
Lid lock mechanism and safety circuit		
Centrifuge lid opens and closes easily and smoothly		
Rubber gasket not damaged		
Centrifuge lid is properly supported by gas lid stay		
Centrifuge lid does not open while rotor is spinning		
Comments:		
Cleanliness of chamber and motor cover		
No particles inside spin chamber		
No corrosion		
Motor cover clean and not damaged		
Comments:		
Rotors and buckets		
No corrosion		
No scratches		
No vertical scratches (carbon fiber rotors)		
Seals in good condition and sealing surfaces not scratched		
Comments:		
AutoLock and motor shaft		
No scratches		
Not bent		
No dents		
Comments:		

Report Number:

Date:

Maintenance after dismantling the centrifuge casing

Acceptance criteria	Pass	Fail
Motor support elements		
Anti vibration mounts not older than 3 years		
Anti vibration mounts in good condition		
Comments:		
Imbalance detection		
Cuts off with "cut off weight"		
Does not cut off with "run through weight"		
Comments:		
Braking circuit		
Brake resistor cold in stand by		
Brake resistor hot during deceleration		
Brake effect smooth and noiseless		
Comments:		
Lead and screwing connections		
All connections on mains inlet socket and power switch tight		
All connections on main board tight		
All other connections tight		
Comments:		
Protection earth core and grounding connections		
Grounding resistance < 200 mΩ		
Insulation resistance > 10 MΩ		
Accessible current < 500 μA		
Comments:		

Comments:

Instrument passed: YES NO

Certified by: _____ Signature _____ Date _____ Reviewed by: _____ Customer Signature _____ Date _____ Expiration date _____

Use ONLY blue permanent ink when filling out.

Leave NO blank spaces.

Oct, 2010

Revised 10/07/12



Calibration certification

**Megafuge 8
ST8 / SL8**

Account name:	Account address:
Instrument model:	serial Number:
Report number:	Date:

SPEED						
Standard test			Rotor used:			
Set speed (rpm)	Tolerance (whichever is greater)	Displayed Speed (rpm)	Measured speed (rpm)	Meets spec. (y/n)	Notes	Passed (initials)
1000	+/- 10 rpm, 1%					
Rotor max	+/- 10 rpm, 1%					
Custom test			Rotor used:			
	+/- 10 rpm, 1%					
	+/- 10 rpm, 1%					

IMBALANCE					
Rotor used:		0°	90°	180°	270°
Rotor cut off weight:	Cuts off (y/n):				
	Passed (Initials):				
Rotor run through weight:	Runs through (y/n):				
	Passed (Initials):				

TIME					
Standard test		Rotor Used:			
Timer Set (min.)	Tolerance (sec.)	Measured time (m/s)	Meets spec. (y/n)	Notes	Passed (initials)
10	+/- 10				
Custom test		Rotor Used:			
	+/- 10				
	+/- 10				

SAFETY TEST			
	Limit	Actual	Passed (initials)
Grounding resistance	< 200 mΩ		
Insulation resistance	> 10 MΩ		
Accessible current	< 500 μA		

TEST EQUIPMENT			
Type	Model	Serial number	Date of next calibration
Stopwatch			
Temperature meter			
Optical tachometer			
Safety tester			

Certified by: _____ Reviewed by: _____ Expiration date _____
Signature Date Customer Signature Date

Use ONLY blue permanent ink when filling out.

Leave NO blank spaces.

June, 1999

Revised 10/07/12

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